Part 29—Airworthiness Standards: Transport Category Rotorcraft

This change incorporates Amendment 29–41, Normal and Transport Category Rotorcraft Regulations, a technical amendment correcting some incorrect word usage and omissions, misspellings, and incorrect references. This amendment affects §§ 29.351, 29.391, 29.562, 29.621, 29.1125, and 29.1521.

Bold brackets enclose the most recently changed or added material. The amendment number and effective date of new material appear in bold brackets at the end of each affected section.

Page Control Chart

Remove Pages	Dated	Insert Pages	Dated
P–373 and P–374	Ch. 6	P–373 through P–376	Ch. 7
Subpart C	Ch. 6	Subpart C	Ch. 7
Subpart D	Ch. 6	Subpart D	Ch. 7
Subpart E	Ch. 6	Subpart E	Ch. 7
Subpart G	Ch. 6	Subpart G	Ch. 7

Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

Section 29.547—Main and tail rotor structure. While manufacturers currently perform the design assessment as an integral part of the design requirements of § 29.917, there will be some incremental costs to formalize the existing information. These costs are included in the cost estimates of § 29.917 summarized below. Formal identification and assessment of critical component failures will increase safety by providing more comprehensive maintenance information to operators. The benefits of averting a single accident will exceed the relatively low incremental costs of compliance.

Section 29.631—Bird strike. Manufacturers indicate that present rotorcraft structures can withstand impacts with 2.2 pound birds; therefore, no incremental manufacturing costs are anticipated. Nonrecurring testing and analysis costs of the requirement are estimated to be $107,000 per type certification. A review of National Transportation Safety Board (NTSB) data for the period 1983–1991 reveals two rotorcraft accidents caused by bird strikes. One accident resulted in one serious injury, one minor injury, and substantial damage to the rotorcraft (tail rotor separation); in the other accident, the rotorcraft was destroyed but there were no injuries. There is at least an equal probability of such accidents in the future, given the tendencies toward higher operating speeds. The benefits of averting a single accident will exceed the incremental costs of the amendment.

Section 29.917—Design. The incremental costs to formalize existing design information for the rotor structure (§ 29.547 above) and drive system are estimated to total $47,000 per type certification. Formal identification and assessment of critical component failures of the rotor drive system will increase safety by providing more comprehensive maintenance information to operators. The benefits of averting a single accident caused directly or indirectly by a lack of relevant data would easily exceed the incremental costs.

Section 29.1587—Performance information. Since the required climb gradient data are already available from the results of flight tests required to obtain performance information, the only additional costs will be those associated with incorporating the data into the Flight Manual, estimated to total $6,000 per type certification. The availability and accuracy of performance data are paramount to operational safety. The benefits of averting a single accident caused directly or indirectly by a lack of relevant performance information will easily exceed the incremental costs.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal Regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed rule would have "a significant economic impact on a substantial number of small entities." Based on the criteria of FAA Order 2100.14A, the FAA has determined that the rule will not have a significant impact on a substantial number of small entities.

The rule will affect manufacturers of future type-certificated normal (part 27) and transport category (part 29) rotorcraft. For manufacturers, Order 2100.14A defines a small entity as one with 75 or fewer employees and a significant economic impact as annualized costs of $19,000 or more. The FAA has determined that the rule will not have a significant economic impact on a substantial number of small manufacturers since (1) no part 29 and only two part 27 rotorcraft manufacturers have 75 or fewer employees, and (2) the annualized certification costs of the rule are less than $19,000.

International Trade Impact Assessment

The rule will not constitute a barrier to international trade, including the export of American rotorcraft to other countries and the import of rotorcraft into the United States. Instead, the changes will harmonize with certification procedures of the JAA and thereby enhance free trade.

Conclusion

For the reasons discussed above, including the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not a significant

Title 14, Code of Federal Regulations (14 CFR parts 27 and 29) effective August 8, 1996.

The authority citation for part 29 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

Amendment 29–41

Normal and Transport Category Rotorcraft Regulations—Technical Amendments

Adopted: August 25, 1997 **Effective: November 28, 1997**

(Published in 62 FR 46172, August 29, 1997)

SUMMARY: This document amends the airworthiness standards for normal and transport category rotorcraft under 14 CFR parts 27 and 29. As published, the final regulations contain some incorrect word usage and omissions, misspellings, and incorrect references that may prove to be misleading and are in need of correction.

DATES: Effective November 28, 1997. Comments for inclusion in the Rules Docket must be received on or before September 29, 1997.

ADDRESSES: Submit comments in duplicate to the Federal Aviation Administration, Office of the Chief Counsel (AGC–200), Attention: Rules Docket No. 29008, 800 Independence Ave., SW., Washington, DC 20591.

Comments may also be submitted electronically to the following Internet address: 9–NPRM–CMTS@faa.dot.gov. Comments submitted must be marked: Docket No. 29008.

Comments may be examined in Room 915G on weekdays between 8:30 a.m. and 5:00 p.m., except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Mary June Bruner, FAA, Fort Worth, Texas 76193–0111, telephone (817) 222–5118, fax (817) 222–5961.

SUPPLEMENTARY INFORMATION: This action makes some nonsubstantive changes to various sections of parts 27 and 29. The affected parts, as published, contain some incorrect word usage and omissions, misspellings, and incorrect references. The FAA has determined that these changes are nonsubstantive and is not aware of any opposition to making these changes.

Further, the European Joint Aviation Authorities (JAA) has notified the FAA that they are issuing a Notice of Proposed Amendment (NPA) to make these same changes to the Joint Aviation Regulations (JAR) 27 and 29. Thus these changes to parts 27 and 29 will be harmonized with the JAA's NPA.

The FAA anticipates that this regulation will not result in adverse or negative comments and therefore is issuing it as technical amendments with request for comments. Since the document would make only nonsubstantive word changes, the FAA is unaware of any opposition to these changes. Unless a written adverse or negative comment, or a written notice of intent to submit an adverse or negative comment is received within the comment period, the regulation will become effective on the date specified. After the close of the comment period, the FAA will publish a document in the *Federal Register* indicating that no adverse or negative comments were received and confirming the date on which the final rule will become effective. If the FAA does receive, within the comment period, an adverse or negative comment, or written notice of intent to submit such a comment, a document withdrawing the amendments extremely helpful in evaluating the effectiveness of this action and determining whether additional rulemaking action would be needed.

Comments are specifically invited on the overall regulatory, economic, environmental, and energy aspects of the rule that might suggest a need to modify the rule. All comments submitted will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons. A report that summarizes each substantive FAA-public contact concerning this action will be filed in the docket.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this rule must submit a self-addressed, stamped postcard on which the following statement is made: ''Comments to Docket No. 29008.'' The postcard will be date stamped and returned to the commenter.

Availability

Using a modem and suitable communications software, an electronic copy of this document may be downloaded from the FAA regulations section of the FedWorld electronic bulletin board service (telephone: 703–321–3339) or the Federal Register's electronic bulletin board service (telephone: 202–512–1661).

Internet users may reach the FAA's web page at http://www.faa.gov or the Federal Register's web page at http://www.access.gpo.gov/su_docs for access to recently published rulemaking documents.

Any person may obtain a copy of this document by submitting a request to the FAA, Office of Rulemaking (ARM–1), 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Communications must identify the amendment number or docket number.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), there are no reporting or recordkeeping requirements associated with this document.

Agency Findings

The regulations adopted herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this rule does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

The FAA has determined that this regulation is noncontroversial and unlikely to result in adverse or negative comments. For the reasons discussed in the preamble, I certify that this regulation (1) is not a ''significant regulatory action'' under Executive Order 12866; (2) is not a ''significant rule'' under DOT Regulatory Policies and Procedures (44 FR 11034, February 26, 1979); and (3) if promulgated, will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. A copy of the regulatory evaluation prepared for this action is contained in the Rules Docket. A copy of it may be obtained by contacting the Rules Docket at the location provided under the caption ''ADDRESSES.''

International Trade Impact Statement

The rule will not constitute a barrier to international trade, including the export of U.S. goods and services to foreign countries and the import of foreign goods and services into the United States.

Unfunded Mandates Reform Act Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), codified as 2 U.S.C. §§ 1501–1571, requires each Federal agency, to the extent permitted by law, to prepare a written assessment a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This regulation is not considered significant under DOT Order 2100.5, Policies and Procedures for Simplification, Analysis, and Review of Regulations.

The Amendment

Accordingly, the Federal Aviation Administration amends 14 CFR parts 27 and 29 effective November 28, 1997.

The authority citation for part 29 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

GENERAL

§ 29.301 Loads.

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

§ 29.303 Factor of safety.

Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.

§ 29.305 Strength and deformation.

(a) The structure must be able to support limit loads without detrimental or permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure. This must be shown by—

(1) Applying ultimate loads to the structure in a static test for at least 3 seconds; or

(2) Dynamic tests simulating actual load application.

§ 29.307 Proof of structure.

(a) Compliance with the strength and deformation requirements of this subpart must be shown for each critical loading condition accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made.

(b) Proof of compliance with the strength requirements of this subpart must include—

(1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;

(2) Limit load tests of the control system, including control surfaces;

(3) Operation tests of the control system;

(4) Flight stress measurement tests;

(5) Landing gear drop tests; and

(6) Any additional tests required for new or unusual design features.

(Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–30, Eff. 4/5/90)

§ 29.309 Design limitations.

The following values and limitations must be established to show compliance with the structural requirements of this subpart:

(a) The design maximum and design minimum weights.

(b) The main rotor r.p.m. ranges, power on and power off.

(c) The maximum forward speeds for each main rotor r.p.m. within the ranges determined under paragraph (b) of this section.

(d) The maximum rearward and sideward flight speeds.

(e) The center of gravity limits corresponding to the limitations determined under paragraphs (b), (c), and (d) of this section.

(f) The rotational speed ratios between each powerplant and each connected rotating component.

(g) The positive and negative limit maneuvering load factors.

FLIGHT LOADS

§ 29.321 General.

(a) The flight load factor must be assumed to act normal to the longitudinal axis of the rotorcraft, and to be equal in magnitude and opposite in direcable load within the operating limitations in the Rotorcraft Flight Manual.

§ 29.337 Limit maneuvering load factor.

The rotorcraft must be designed for—

(a) A limit maneuvering load factor ranging from a positive limit of 3.5 to a negative limit of -1.0; or

(b) Any positive limit maneuvering load factor not less than 2.0 and any negative limit maneuvering load factor of not less than -0.5 for which—

(1) The probability of being exceeded is shown by analysis and flight tests to be extremely remote; and

(2) The selected values are appropriate to each weight condition between the design maximum and design minimum weights.

(Amdt. 29–30, Eff. 4/5/90)

§ 29.339 Resultant limit maneuvering loads.

The loads resulting from the application of limit maneuvering load factors are assumed to act at the center of each rotor hub and at each auxiliary lifting surface, and to act in directions and with distributions of load among the rotors and auxiliary lifting surfaces, so as to represent each critical maneuvering condition, including power-on and power-off flight with the maximum design rotor tip speed ratio. The rotor tip speed ratio is the ratio of the rotorcraft flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades, and is expressed as follows:

$$\mu = \frac{V \cos a}{\Omega R}$$

where—

V = The airspeed along the flight path (f.p.s.);

a = The angle between the projection, in the plane of symmetry, of the axis of no feathering and a line perpendicular to the flight path (radians, positive when axis is pointing aft);

Ω = The angular velocity of rotor (radians per second); and

R = The rotor radius (ft.).

§ 29.351 Yawing conditions.

(a) Each rotorcraft must be designed for the loads resulting from the maneuvers specified in paragraphs (b) and (c) of this section, with—

(1) Unbalanced aerodynamic moments about the center of gravity which the aircraft reacts to in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces; and

(2) Maximum main rotor speed.

(b) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from zero up to 0.6 V_{NE}—

(1) Displace the cockpit [directional] control suddenly to the maximum deflection limited by the control stops or by the maximum pilot force specified in [§ 29.397(a)];

(2) Attain a resulting sideslip angle or 90°, whichever is less; and

(3) Return the directional control suddenly to neutral.

(c) To produce the load required in paragraph (a) of the section, in unaccelerated flight with zero yaw, at forward speeds from 0.6 V_{NE} up to V_{NE} or V_H, whichever is less—

(1) Displace the cockpit directional control suddenly to the maximum deflection limited by the control stops or by the [maximum] pilot force specified in [§ 29.397(a)];

(2) Attain a resulting sideslip angle or 15°, whichever is less, at the lesser speed of V_{NE} or V_H;

(3) Vary the sideslip angles of paragraphs (b)(2) and (c)(2) of this section directly with speed; and

(4) Return the directional control suddenly to neutral.

(Amdt. 29–30, Eff. 4/5/90); [(Amdt. 29–41, Eff. 11/28/97)]

§ 29.361 Engine torque.

The limit engine torque may not be less than the following:

(a) For turbine engines, the highest of—

(1) The mean torque for maximum continuous power multiplied by 1.25;

(1) 1.33, for engines with five or more cylinders; and

(2) Two, three, and four, for engines with four, three, and two cylinders, respectively.

(Amdt. 29–26, Eff. 10/3/88)

CONTROL SURFACE AND SYSTEM LOADS

§ 29.391 General.

Each auxiliary rotor, each fixed or movable stabilizing or control surface, and each system operating any flight control must meet the requirements of §§ 29.395 through [29.399, 29.411, and 29.427.]

(Amdt. 29–30, Eff. 4/5/90); [(Amdt. 29–41, Eff. 11/28/97)]

§ 29.395 Control system.

(a) The reaction to the loads prescribed in § 29.397 must be provided by—

(1) The control stops only;

(2) The control locks only;

(3) The irreversible mechanism only (with the mechanism locked and with the control surface in the critical positions for the effective parts of the system within its limit of motion);

(4) The attachment of the control system to the rotor blade pitch control horn only (with the control in the critical positions for the affected parts of the system within the limits of its motion); and

(5) The attachment of the control system to the control surface horn (with the control in the critical positions for the affected parts of the system within the limits of its motion).

(b) Each primary control system, including its supporting structure, must be designed as follows:

(1) The system must withstand loads resulting from the limit pilot forces prescribed in § 29.397;

(2) Notwithstanding paragraph (b)(3) of this section, when power-operated actuator controls or power boost controls are used, the system must also withstand the loads resulting from the limit pilot forces prescribed in § 29.397 in conjunction with the forces output of each normally energized power device, including any single power boost or actuator system failure;

(3) If the system design or the normal operating loads are such that a part of the system cannot react to the limit pilot forces prescribed in § 29.397, that part of the system must be designed to withstand the maximum loads that can be obtained in normal operation. The minimum design loads must, in any case, provide a rugged system for service use, including consideration of fatigue, jamming, ground gusts, control inertia, and friction loads. In the absence of a rational analysis, the design loads resulting from 0.60 of the specified limit pilot forces are acceptable minimum design loads; and

(4) If operational loads may be exceeded through jamming, ground gusts, control inertia, or friction, the system must withstand the limit pilot forces specified in § 29.397, without yielding.

(Amdt. 29–30, Eff. 4/5/90)

§ 29.397 Limit pilot forces and torques.

(a) Except as provided in paragraph (b) of this section, the limit pilot forces are as follows:

(1) For foot controls, 130 pounds.

(2) For stick controls, 100 pounds fore and aft, and 67 pounds laterally.

(b) For flap, tab, stabilizer, rotor brake, and landing gear operating controls, the following apply (R=radius in inches):

(1) Crank, wheel, and lever controls, [1+R]/3×50 pounds, but not less than 50 pounds nor more than 100 pounds for hand operated controls or 130 pounds for foot operated controls, applied at any angle within 20 degrees of the plane of motion of the control.

(2) Twist controls, 80R pounds.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.399 Dual control system.

Each dual primary flight control system must be able to withstand the loads that result when pilot forces not less than 0.75 times those obtained under § 29.395 are applied—

(a) In opposition; and

(b) In the same direction.

contact the landing surface during a normal landing.

(b) If a tail rotor guard is required to show compliance with paragraph (a) of this section—

(1) Suitable design loads must be established for the guard; and

(2) The guard and its supporting structure must be designed to withstand those loads.

§ 29.413 [Removed]

§ 29.427 Unsymmetrical loads.

(a) Horizontal tail surfaces and their supporting structure must be designed for unsymmetrical loads arising from yawing and rotor wake effects in combination with the prescribed flight conditions.

(b) To meet the design criteria of paragraph (a) of this section, in the absence of more rational data, both of the following must be met:

(1) One hundred percent of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry, and no loading acts on the other side.

(2) Fifty percent of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry, in opposite directions.

(c) For empennage arrangements where the horizontal tail surfaces are supported by the vertical tail surfaces, the vertical tail surfaces and supporting structure must be designed for the combined vertical and horizontal surface loads resulting from each prescribed flight condition, considered separately. The flight conditions must be selected so that the maximum design loads are obtained on each surface. In the absence of more rational data, the unsymmetrical horizontal tail surface loading distributions described in this section must be assumed.

(Amdt. 29–30, Eff. 4/5/90); (Amdt. 29–31, Eff. 10/22/90)

GROUND LOADS

§ 29.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

linear and angular inertia loads in a rational or conservative manner.

(b) *Critical centers of gravity.* The critical centers of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element.

§ 29.473 Ground loading conditions and assumptions.

(a) For specified landing conditions, a design maximum weight must be used that is not less than the maximum weight. A rotor lift may be assumed to act through the center of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight.

(b) Unless otherwise prescribed, for each specified landing condition, the rotorcraft must be designed for a limit load factor of not less than the limit inertia load factor substantiated under § 29.725.

(c) Triggering or actuating devices for additional or supplementary energy absorption may not fail under loads established in the tests prescribed in §§ 29.725 and 29.727, but the factor of safety prescribed in § 29.303 need not be used.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.475 Tires and shock absorbers.

Unless otherwise prescribed, for each specified landing condition, the tires must be assumed to be in their static position and the shock absorbers to be in their most critical position.

§ 29.477 Landing gear arrangement.

Sections 29.235, 29.479 through 29.485, and 29.493 apply to landing gear with two wheels aft, and one or more wheels forward, of the center of gravity.

§ 29.479 Level landing conditions.

(a) *Attitudes.* Under each of the loading conditions prescribed in paragraph (b) of this section, the rotorcraft is assumed to be in each of the following level landing attitudes:

tions:

(1) Vertical loads applied under § 29.471.

(2) The loads resulting from a combination of the loads applied under paragraph (b)(1) of this section with drag loads at each wheel of not less than 25 percent of the vertical load at that wheel.

(3) The vertical load at the instant of peak drag load combined with a drag component simulating the forces required to accelerate the wheel rolling assembly up to the specified ground speed, with—

(i) The ground speed for determination of the spin-up loads being at least 75 percent of the optimum forward flight speed for minimum rate of descent in autorotation; and

(ii) The loading conditions of paragraph (b) applied to the landing gear and its attaching structure only.

(4) If there are two wheels forward, a distribution of the loads applied to those wheels under paragraphs (b)(1) and (2) of this section in a ratio of 40:60.

(c) *Pitching moments.* Pitching moments are assumed to be resisted by—

(1) In the case of the attitude in paragraph (a)(1) of this section, the forward landing gear; and

(2) In the case of the attitude in paragraph (a)(2) of this section, the angular inertia forces.

§ 29.481 Tail-down landing conditions.

(a) The rotorcraft is assumed to be in the maximum nose-up attitude allowing ground clearance by each part of the rotorcraft.

(b) In this attitude, ground loads are assumed to act perpendicular to the ground.

§ 29.483 One-wheel landing conditions.

For the one-wheel landing condition, the rotorcraft is assumed to be in the level attitude and to contact the ground on one aft wheel. In this attitude—

(a) The vertical load must be the same as that obtained on that side under § 29.479(b)(1); and

(1) Side loads combined with one-half of the maximum ground reactions obtained in the level landing conditions of § 29.479(b)(1); and

(2) The loads obtained under paragraph (a)(1) of this section applied—

(i) At the ground contact point; or

(ii) For full-swiveling gear, at the center of the axle.

(b) The rotorcraft must be designed to withstand, at ground contact—

(1) When only the aft wheels contact the ground, side loads of 0.8 times the vertical reaction acting inward on one side and 0.6 times the vertical reaction acting outward on the other side, all combined with the vertical loads specified in paragraph (a) of this section; and

(2) When the wheels contact the ground simultaneously—

(i) For the aft wheels, the side loads specified in paragraph (b)(1) of this section; and

(ii) For the forward wheels, a side load of 0.8 times the vertical reaction combined with the vertical load specified in paragraph (a) of this section.

§ 29.493 Braked roll conditions.

Under braked roll conditions with the shock absorbers in their static positions—

(a) The limit vertical load must be based on a load factor of at least—

(1) 1.33, for the attitude specified in § 29.479(a)(1); and

(2) 1.0, for the attitude specified in § 29.479(a)(2); and

(b) The structure must be designed to withstand, at the ground contact point of each wheel with brakes, a drag load of at least the lesser of—

(1) The vertical load multiplied by a coefficient of friction of 0.8; and

(2) The maximum value based on limiting brake torque.

§ 29.497 Ground loading conditions: Landing gear with tail wheels.

(a) *General.* Rotorcraft with landing gear with two wheels forward and one wheel aft of the center combined with a drag load at that axle of not less than 25 percent of that vertical load; and

(3) Unbalanced pitching moments are assumed to be resisted by angular inertia forces.

(c) *Level landing attitude with all wheels contacting the ground simultaneously.* In this attitude, the rotorcraft must be designed for landing loading conditions as prescribed in paragraph (b) of this section.

(d) *Maximum nose-up attitude with only the rear wheel contacting the ground.* The attitude for this condition must be the maximum nose-up attitude expected in normal operation, including autorotative landings. In this attitude—

(1) The appropriate ground loads specified in paragraph (b)(1) and (2) of this section must be determined and applied, using a rational method to account for the moment arm between the rear wheel ground reaction and the rotorcraft center of gravity; or

(2) The probability of landing with initial contact on the rear wheel must be shown to be extremely remote.

(e) *Level landing attitude with only forward wheel contacting the ground.* In this attitude, the rotorcraft must be designed for ground loads as specified in paragraph (b)(1) and (3) of this section.

(f) *Side loads in the level landing attitude.* In the attitudes specified in paragraphs (b) and (c) of this section, the following apply:

(1) The side loads must be combined at each wheel with one-half of the maximum vertical ground reactions obtained for that wheel under paragraphs (b) and (c) of this section. In this condition, the side loads must be—

(i) For the forward wheels, 0.8 times the vertical reaction (on one side) acting inward, and 0.6 times the vertical reaction (on the other side) acting outward; and

(ii) For the rear wheel, 0.8 times the vertical reaction.

(2) The loads specified in paragraph (f)(1) of this section must be applied—

(i) At the ground contact point with the wheel in the trailing position (for non full swiveling landing gear or for full swiveling landing gear with a lock, steering device, or

and (c) of this section, and with the shock absorbers in their static positions, the rotorcraft must be designed for braked roll loads as follows:

(1) The limit vertical load must be based on a limit vertical load factor of not less than—

(i) 1.0, for the attitude specified in paragraph (b) of this section; and

(ii) 1.33, for the attitude specified in paragraph (c) of this section.

(2) For each wheel with brakes, a drag load must be applied, at the ground contact point, of not less than the lesser of—

(i) 0.8 times the vertical load; and

(ii) The maximum based on limiting brake torque.

(h) *Rear wheel turning loads in the static ground attitude.* In the static ground attitude, and with the shock absorbers and tires in their static positions, the rotorcraft must be designed for rear wheel turning loads as follows:

(1) A vertical ground reaction equal to the static load on the rear wheel must be combined with an equal side load.

(2) The load specified in paragraph (h)(1) of this section must be applied to the rear landing gear—

(i) Through the axle, if there is a swivel (the rear wheel being assumed to be swiveled 90° to the longitudinal axis of the rotorcraft); or

(ii) At the ground contact point if there is a lock, steering device or shimmy damper (the rear wheel being assumed to be in the trailing position).

(i) *Taxiing condition.* The rotorcraft and its landing gear must be designed for the loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

§ 29.501 Ground loading conditions: Landing gear with skids.

(a) *General.* Rotorcraft with landing gear with skids must be designed for the loading conditions specified in this section. In showing compliance with this section, the following apply:

drop test of the gear with—

(i) A drop height of 1.5 times that specified in § 29.725; and

(ii) An assumed rotor lift of not more than 1.5 times that used in the limit drop tests prescribed in § 29.725.

(4) Compliance with paragraphs (b) through (e) of this section must be shown with—

(i) The gear in its most critically deflected position for the landing condition being considered; and

(ii) The ground reactions rationally distributed along the bottom of the skid tube.

(b) *Vertical reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the vertical reactions must be applied as prescribed in paragraph (a) of this section.

(c) *Drag reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

(1) The vertical reactions must be combined with horizontal drag reactions of 50 percent of the vertical reaction applied at the ground.

(2) The resultant ground loads must equal the vertical load specified in paragraph (b) of this section.

(d) *Sideloads in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

(1) The vertical ground reaction must be—

(i) Equal to the vertical loads obtained in the condition specified in paragraph (b) of this section; and

(ii) Divided equally among the skids.

(2) The vertical ground reactions must be combined with a horizontal sideload of 25 percent of their value.

(3) The total sideload must be applied equally between skids and along the length of the skids.

(4) The unbalanced moments are assumed to be resisted by angular inertia.

(5) The skid gear must be investigated for—

(i) Inward acting sideloads; and

side in the condition specified in paragraph (b) of this section.

(2) The unbalanced moments are assumed to be resisted by angular inertia.

(f) *Special conditions.* In addition to the conditions specified in paragraphs (b) and (c) of this section, the rotorcraft must be designed for the following ground reactions:

(1) A ground reaction load acting up and aft at an angle of 45° to the longitudinal axis of the rotorcraft. This load must be—

(i) Equal to 1.33 times the maximum weight;

(ii) Distributed symmetrically among the skids;

(iii) Concentrated at the forward end of the straight part of the skid tube; and

(iv) Applied only to the forward end of the skid tube and its attachment to the rotorcraft.

(2) With the rotorcraft in the level landing attitude, a vertical ground reaction load equal to one-half of the vertical load determined under paragraph (b) of this section. This load must be—

(i) Applied only to the skid tube and its attachment to the rotorcraft; and

(ii) Distributed equally over 33.3 percent of the length between the skid tube attachments and centrally located midway between the skid tube attachments.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–30, Eff. 4/5/90)

§ 29.505 Ski landing conditions.

If certification for ski operation is requested, the rotorcraft with skis, must be designed to withstand the following loading conditions (where P is the maximum static weight on each ski with the rotorcraft at design maximum weight, and n is the limit load factor determined under § 29.473(b)):

(a) Up-load conditions in which—

(1) A vertical load of Pn and a horizontal load of $Pn/4$ are simultaneously applied at the pedestal bearings; and

(2) A vertical load of 1.33 P is applied at the pedestal bearings.

(b) A side load condition in which a side load of 0.35 Pn is applied at the pedestal bearings in

29.511 Ground load: Unsymmetrical loads on multiple-wheel units.

(a) In dual-wheel gear units, 60 percent of the total ground reaction for the gear unit must be applied to one wheel and 40 percent to the other.

(b) To provide for the case of one deflated tire, 60 percent of the specified load for the gear unit must be applied to either wheel except that the vertical ground reaction may not be less than the full static value.

(c) In determining the total load on a gear unit, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(Amdt. 29–3, Eff. 2/25/68)

WATER LOADS

§ 29.519 Hull type rotorcraft: Water-based and amphibian.

(a) *General.* For hull type rotorcraft, the structure must be designed to withstand the water loading set forth in paragraphs (b), (c), and (d) of this section considering the most severe wave heights and profiles for which approval is desired. The loads for the landing conditions of paragraphs (b) and (c) of this section must be developed and distributed along and among the hull and auxiliary floats, if used, in a rational and conservative manner, assuming a rotor lift not exceeding two-thirds of the rotorcraft weight to act throughout the landing impact.

(b) *Vertical landing conditions.* The rotorcraft must initially contact the most critical wave surface at zero forward speed in likely pitch and roll attitudes which result in critical design loadings. The vertical descent velocity may not be less than 6.5 feet per second relative to the mean water surface.

(c) *Forward speed landing conditions.* The rotorcraft must contact the most critical wave at forward velocities from zero up to 30 knots in likely pitch, roll, and yaw attitudes and with a vertical descent velocity of not less than 6.5 feet per second relative to the mean water surface. A maximum forward velocity of less than 30 knots may be used in design if it can be demonstrated that the forward be shown that full immersion of the float is unlikely, in which case the highest likely float buoyancy load must be applied that considers loading of the float immersed to create restoring moments compensating for upsetting moments caused by side wind, asymmetrical rotorcraft loading, water wave action, and rotorcraft inertia.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–30, Eff. 4/5/90)

§ 29.521 Float landing conditions.

If certification for float operation (including float amphibian operation) is requested, the rotorcraft, with floats, must be designed to withstand the following loading conditions (where the limit load factor is determined under § 29.473(b) or assumed to be equal to that determined for wheel landing gear):

(a) Up-load conditions in which—

(1) A load is applied so that, with the rotorcraft in the static level attitude, the resultant water reaction passes vertically through the center of gravity; and

(2) The vertical load prescribed in paragraph (a)(1) of this section is applied simultaneously with an aft component of 0.25 times the vertical component.

(b) A side load condition in which—

(1) A vertical load of 0.75 times the total vertical load specified in paragraph (a)(1) of this section is divided equally among the floats; and

(2) For each float, the load share determined under paragraph (b)(1) of this section, combined with a total side load of 0.25 times the total vertical load specified in paragraph (b)(1) of this section, is applied to that float only.

(Amdt. 29–3, Eff. 2/25/68)

MAIN COMPONENT REQUIREMENTS

§ 29.547 [Main and tail rotor structure.]

[(a) A rotor is an assembly of rotating components, which includes the rotor hub, blades, blade dampers, the pitch control mechanisms, and all other parts that rotate with the assembly.

likelihood of their occurrence.

[(c) The rotor structure must be designed to withstand the following loads prescribed in §§ 29.337 through 29.341 and 29.351:]

(1) Critical flight loads.

(2) Limit loads occurring under normal conditions of autorotation.

(d) [The rotor structure must be designed to withstand loads simulating—]

(1) For the rotor blades, hubs, and flapping hinges, the impact force of each blade against its stop during ground operation; and

(2) Any other critical condition expected in normal operation.

(e) [The rotor structure must be designed to withstand the limit torque at any rotational speed, including zero.

In addition:]

(1) The limit torque need not be greater than the torque defined by a torque limiting device (where provided), and may not be less than the greater of—

(i) The maximum torque likely to be transmitted to the rotor structure, in either direction, by the rotor drive or by sudden application of the rotor brake; and

(ii) [For the main rotor, the limit engine torque specified in § 29.361.]

(2) The limit torque must be equally and rationally distributed to the rotor blades.

(Amdt. 29–4, Eff. 10/17/68); [(Amdt. 29–40, Eff. 8/8/96)]

§ 29.549 Fuselage and rotor pylon structures.

(a) Each fuselage and rotor pylon structure must be designed to withstand—

(1) The critical loads prescribed in §§ 29.337 through 29.341, and 29.351;

(2) The applicable ground loads prescribed in §§ 29.235, 29.471 through 29.485, 29.493, 29.497, 29.505, and 29.521; and

(3) The loads prescribed in § 29.547(d)(1) and (e)(1)(i).

(b) Auxiliary rotor thrust, the torque reaction of each rotor drive system, and the balancing air and

(e) If approval for the use of 2½-minute OEI power is requested, each engine mount and adjacent structure must be designed to withstand the loads resulting from a limit torque equal to 1.25 times the mean torque for 2½-minute power OEI combined with 1g flight loads.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–26, Eff. 10/3/88)

§ 29.551 Auxiliary lifting surfaces.

Each auxiliary lifting surface must be designed to withstand—

(a) The critical flight loads in §§ 29.337 through 29.341, and 29.351;

(b) The applicable ground loads in §§ 29.235, 29.471 through 29.485, 29.493, 29.505, and 29.521; and

(c) Any other critical condition expected in normal operation.

EMERGENCY LANDING CONDITIONS

§ 29.561 General.

(a) The rotorcraft, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this section to protect the occupants under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when—

(1) Proper use is made of seats, belts, and other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) Each occupant and each item of mass inside the cabin that could injure an occupant is restrained when subjected to the following ultimate inertial load factors relative to the surrounding structure:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g, after the intended displacement of the seat device.

[(v) Rearward—1.5g.]

ited to, rotors, transmission, and engines. The items of mass must be restrained for the following ultimate inertial load factors:

(1) Upward—1.5g.

(2) Forward—[12g.]

(3) Sideward—[6g.]

(4) Downward—[12g.]

[(5) Rearward—1.5g.]

(d) Any fuselage structure in the area of internal fuel tanks below the passenger floor level must be designed to resist the following ultimate inertial factors and loads, and to protect the fuel tanks from rupture, if rupture is likely when those loads are applied to that area:

(1) Upward—1.5g.

(2) Forward—4.0g.

(3) Sideward—2.0g.

(4) Downward—4.0g.

(Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–29, Eff. 12/13/89); [(Amdt. 29–38, Eff. 6/11/96)]

§ 29.562 Emergency landing dynamic conditions.

(a) The rotorcraft, although it may be damaged in a crash landing, must be designed to reasonably protect each occupant when—

(1) The occupant properly uses the seats, safety belts, and shoulder harnesses provided in the design; and

(2) The occupant is exposed to loads equivalent to those resulting from the conditions prescribed in this section.

(b) Each seat type design or other seating device approved for crew or passenger occupancy during takeoff and landing must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat in accordance with the following criteria. The test must be conducted with an occupant simulated by a 170-pound anthropomorphic test dummy (ATD), as defined by 49 CFR 572, subpart B, or its equivalent, sitting in the normal upright position.

(1) A change in downward velocity of not less than 30 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference impact and must reach a minimum of 30g's.

(2) A change in forward velocity of not less than 42 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is yawed 10° either right or left of the impact velocity vector (whichever would cause the greatest load on the shoulder harness), the rotorcraft's lateral axis is contained in a horizontal plane containing the impact velocity vector, and the rotorcraft's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. Peak floor deceleration must occur in not more than 0.071 seconds after impact and must reach a minimum of 18.4g's.

(3) When floor rails or floor or [sidewall attachment] devices are used to attach the seating devices to the airframe structure for the conditions of this section, the rails or devices must be misaligned with respect to each other by at least 10° vertically (i.e., pitch out of parallel) and by at least a 10° lateral roll, with the directions optional, to account for possible floor warp.

(c) Compliance with the following must be shown:

(1) The seating device system must remain intact although it may experience separation intended as part of its design.

(2) The attachment between the seating device and the airframe structure must remain intact although the structure may have exceeded its limit load.

(3) The ATDs shoulder harness strap or straps must remain on or in the immediate vicinity of the ATDs shoulder during the impact.

(4) The safety belt must remain on the ATDs pelvis during the impact.

(5) The ATDs head either does not contact any portion of the crew or passenger compartment or, if contact is made, the head impact does not exceed a head injury criteria (HIC) of 1,000 as determined by this equation.

$$HIC=(t_2-t_1)\left[\frac{1}{(t_2-t_1)}\int_{t_1}^{t_2} a(t)dt\right]^{2.5}$$

are used for retaining the upper torso, the total harness strap loads must not exceed 2,000 pounds.

(7) The maximum compressive load measured between the pelvis and the lumbar column of the ATD must not exceed 1,500 pounds.

(d) An alternate approach that achieves an equivalent or greater level of occupant protection, as required by this section, must be substantiated on a rational basis.

(Amdt. 29–29, Eff. 12/13/89); [(Amdt. 29–41, Eff. 11/28/97)]

§ 29.563 Structural ditching provisions.

If certification with ditching provisions is requested, structural strength for ditching must meet the requirements of this section and § 29.801(e).

(a) *Forward speed landing conditions.* The rotorcraft must initially contact the most critical wave for reasonably probable water conditions at forward velocities from zero up to 30 knots in likely pitch, roll, and yaw attitudes. The rotorcraft limit vertical descent velocity may not be less than 5 feet per second relative to the mean water surface. Rotor lift may be used to act through the center of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight. A maximum forward velocity of less than 30 knots may be used in design if it can be demonstrated that the forward velocity selected would not be exceeded in a normal one-engine-out touchdown.

(b) *Auxiliary or emergency float conditions.*

(1) *Floats fixed or deployed before initial water contact.* In addition to the landing loads in paragraph (a) of this section, each auxiliary or emergency float, or its support and attaching structure in the airframe or fuselage, must be designed for the load developed by a fully immersed float unless it can be shown that full immersion is unlikely. If full immersion is unlikely, the highest. likely float buoyancy load must be applied. The highest likely buoyancy load must include consideration of a partially immersed float creating restoring moments to compensate the upsetting moments caused by side wind, unsymmetrical rotorcraft loading, water wave action, rotorcraft inertia, and probable structural damage and leakage considered under § 29.801(d). Maximum roll and pitch angles determined from compliance with § 29.801(d) may be used, if significant, to determine the extent of immersion of each float. If the floats are deployed in flight, appropriate air loads derived from the flight limitations with the floats deployed shall be used in substantiation of the floats and their attachment to the rotorcraft. For this purpose, the design airspeed for limit load is the float deployed airspeed operating limit multiplied by 1.11.

(2) *Floats deployed after initial water contact.* Each float must be designed for full or partial immersion prescribed in paragraph (b)(1) of this section. In addition, each float must be designed for combined vertical and drag loads using a relative limit speed of 20 knots between the rotorcraft and the water. The vertical load may not be less than the highest likely buoyancy load determined under paragraph (b)(1) of this section.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–30, Eff. 4/5/90)

FATIGUE EVALUATION

§ 29.571 Fatigue evaluation of structure.

(a) *General.* An evaluation of the strength of principal elements, detail design points, and fabrication techniques must show that catastrophic failure due to fatigue, considering the effects of environment, intrinsic/discrete flaws, or accidental damage will be avoided. Parts to be evaluated include, but are not limited to, rotors, rotor drive systems between the engines and rotor hubs, controls, fuselage, fixed and movable control surfaces, engine and transmission mountings, landing gear, and their related primary attachments. In addition, the following apply:

(1) Each evaluation required by this section must include—

(i) The identification of principal structural elements, the failure of which could result in catastrophic failure of the rotorcraft;

(ii) In-flight measurement in determining the loads or stresses for items in paragraph (a)(1)(i) of this section in all critical conditions throughout the range of limitations in § 29.309 (including altitude effects), except that maneuvering load factors need not exceed the maximum values expected in operations; and

(iii) Loading spectra as severe as those expected in operation based on loads or stresses determined under paragraph (a)(1)(ii)

These inspections, replacement times, combinations thereof, or other procedures must be included in the airworthiness limitations section of the Instructions for Continued Airworthiness required by § 29.1529 and Section A29.4 of appendix A of this part.

(b) *Fatigue tolerance evaluation (including tolerance to flaws).* The structure must be shown by analysis supported by test evidence and, if available, service experience to be of fatigue tolerant design. The fatigue tolerance evaluation must include the requirements of either paragraph (b)(1), (2), or (3) of this section, or a combination thereof, and also must include a determination of the probable locations and modes of damage caused by fatigue, considering environmental effects, intrinsic/discrete flaws, or accidental damage. Compliance with the flaw tolerance requirements of paragraph (b)(1) or (2) of this section is required unless the applicant establishes that these fatigue flaw tolerant methods for a particular structure cannot be achieved within the limitations of geometry, inspectability, or good design practice. Under these circumstances, the safe-life evaluation of paragraph (b)(3) of this section is required.

(1) *Flaw tolerant safe-life evaluation.* It must be shown that the structure, with flaws present, is able to withstand repeated loads of variable magnitude without detectable flaw growth for the following time intervals—

to withstand design limit loads without failure within an inspection period furnished under Section A29.4 of appendix A to this part. Limit loads are defined in § 29.301(a).

(i) The residual strength evaluation must show that the remaining structure after flaw growth is able to withstand design limit loads without failure within its operational life.

(ii) Inspection intervals and methods must be established as necessary to ensure that failures are detected prior to residual strength conditions being reached.

(iii) If significant changes in structural stiffness or geometry, or both, follow from a structural failure or partial failure, the effect on flaw tolerance must be further investigated.

(3) *Safe-life evaluation.* It must be shown that the structure is able to withstand repeated loads of variable magnitude detectable cracks for the following time intervals—

(i) Life of the rotorcraft; or

(ii) Within a replacement time furnished under Section A29.4 of appendix A to this part.

(Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–20, Eff. 10/14/80); (Amdt. 29–28, Eff. 11/27/89)

GENERAL

§ 29.601 Design.

(a) The rotorcraft may have no design features or details that experience has shown to be hazardous or unreliable.

(b) The suitability of each questionable design detail and part must be established by tests.

§ 29.603 Materials.

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must—

(a) Be established on the basis of experience or tests;

(b) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–17, Eff. 12/1/78)

§ 29.605 Fabrication methods.

(a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed according to an approved process specification.

(b) Each new aircraft fabrication method must be substantiated by a test program.

(Amdt. 29–17, Eff. 12/1/78)

§ 29.607 Fasteners.

(a) Each removable bolt, screw, nut, pin, or other fastener whose loss could jeopardize the safe operation of the rotorcraft must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

(b) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.

(Amdt. 29–5, Eff. 10/27/68)

§ 29.609 Protection of structure.

Each part of the structure must—

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including—

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary to prevent the accumulation of corrosive, flammable, or noxious fluids.

§ 29.610 [Lightning and static electricity protection.]

(a) [The rotorcraft structure must be protected against catastrophic effects from lightning.]

(b) For metallic components, compliance with paragraph (a) of this section may be shown by—

(1) Electrically bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the rotorcraft.

(c) For nonmetallic components, compliance with paragraph (a) of this section may be shown by—

(1) Designing the components to minimize the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current to not endanger the rotorcraft.

[(d) The electric bonding and protection against lightning and static electricity must—

[(1) Minimize the accumulation of electrostatic charge;

[(2) Minimize the risk of electric shock to crew, passengers, and service and maintenance personnel using normal precautions;

(Amdt. 29–24, Eff. 12/6/84); [(Amdt. 29–40, Eff. 8/8/96)]

§ 29.611 Inspection provisions.

There must be means to allow close examination of each part that requires—

(a) Recurring inspection;

(b) Adjustment for proper alignment and functioning; or

(c) Lubrication.

§ 29.613 Material strength properties and design values.

(a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.

(b) Design values must be chosen to minimize the probability of structural failure due to material variability. Except as provided in paragraphs (d) and (e) of this section, compliance with this paragraph must be shown by selecting design values that assure material strength with the following probability—

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99 percent probability with 95 percent confidence; and

(2) For redundant structures, those in which the failure of individual elements would result in applied loads being safely distributed to other load-carrying members, 90 percent probability with 95 percent confidence.

(c) The strength, detail design, and fabrication of the structure must minimize the probability of disastrous fatigue failure, particularly at points of stress concentration;

(d) Design values may be those contained in the following publications (available from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120) or other values approved by the Administrator:

(1) MIL—HDBK-5, "Metallic Materials and Elements for Flight Vehicle Structure".

(2) MIL—HDBK-17, "Plastics for Flight Vehicles".

it is determined that the actual strength properties of that particular item will equal or exceed those used in design.

(Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–30, Eff. 4/5/90)

§ 29.619 Special factors.

(a) The special factors prescribed in §§ 29.621 through 29.625 apply to each part of the structure whose strength is—

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability due to—

(i) Uncertainties in manufacturing processes; or

(ii) Uncertainties in inspection methods.

(b) For each part of the rotorcraft to which §§ 29.621 through 29.625 apply, the factor of safety prescribed in § 29.303 must be multiplied by a special factor equal to—

(1) The applicable special factors prescribed in §§ 29.621 through 29.625; or

(2) Any other factor great enough to ensure that the probability of the part being understrength because of the uncertainties specified in paragraph (a) of this section is extremely remote.

§ 29.621 Casting factors.

(a) *General.* The factors, tests, and inspections specified in paragraphs (b) and (c) of this section must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Paragraphs (c) and (d) of this section apply to structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) *Bearing stresses and surfaces.* The casting factors specified in paragraphs (c) and (d) of this section—

(1) Need not exceed 1.25 with respect to bearing stresses regardless of the method of inspection used; and

(1) Each critical casting must—

(i) Have a casting factor of not less than 1.25; and

(ii) Receive 100 percent inspection by visual, radiographic, and magnetic particle (for ferromagnetic materials) or [penetrant] (for nonferromagnetic materials) inspection methods or approved equivalent inspection methods.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet—

(i) The strength requirements of § 29.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of § 29.305 at a load of 1.15 times the limit load.

(d) *Noncritical castings.* For each casting other than those specified in paragraph (c) of this section, the following apply:

(1) Except as provided in paragraphs (d)(2) and (3) of this section, the casting factors and corresponding inspections must meet the following table:

Casting factor	*Inspection*
2.0 or greater	100 percent visual.
Less than 2.0, greater than 1.5	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), or approved equivalent inspection methods.
1.25 through 1.50	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (non ferromagnetic materials), and radiographic or approved equivalent inspection methods.

(2) The percentage of castings inspected by nonvisual methods may be reduced below that specified in paragraph (d)(1) of this section when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis—

(i) A casting factor of 1.0 may be used; and

(a) Except as provided in paragraph (b) of this section, each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used on a part for which any larger special factor is prescribed.

§ 29.625 Fitting factors.

For each fitting (part or terminal used to join one structural member to another) the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of—

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used—

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood); and

(2) With respect to any bearing surface for which a larger special factor is used.

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the section properties become typical of the member.

§ 29.629 [Flutter and divergence.]

[Each aerodynamic surface of the rotorcraft must be free from flutter and divergence under each appropriate speed and power condition.]

(Amdt. 29–30, Eff. 4/5/90); [(Amdt. 29–40, Eff. 8/8/96)]

[§ 29.631 Bird strike.

[The rotorcraft must be designated to ensure capability of continued safe flight and landing (for Category A) or safe landing (for Category B) after impact with a 2.2-lb (1.0 kg) bird when the velocity of the rotorcraft (relative to the bird along the flight path of the rotorcraft) is equal to V_{NE} or VH

§ 29.653 Pressure venting and drainage of rotor blades.

(a) For each rotor blade—

(1) There must be means for venting the internal pressure of the blade;

(2) Drainage holes must be provided for the blade; and

(3) The blade must be designed to prevent water from becoming trapped in it.

(b) Paragraphs (a)(1) and (2) of this section does not apply to sealed rotor blades capable of withstanding the maximum pressure differentials expected in service.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.659 Mass balance.

(a) The rotor and blades must be mass balanced as necessary to—

(1) Prevent excessive vibration; and

(2) Prevent flutter at any speed up to the maximum forward speed.

(b) The structural integrity of the mass balance installation must be substantiated.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.661 Rotor blade clearance.

There must be enough clearance between the rotor blades and other parts of the structure to prevent the blades from striking any part of the structure during any operating condition.

§ 29.663 Ground resonance prevention means.

(a) The reliability of the means for preventing ground resonance must be shown either by analysis and tests, or reliable service experience, or by showing through analysis or tests that malfunction or failure of a single means will not cause ground resonance.

(b) The probable range of variations, during service, of the damping action of the ground resonance

§ 29.671 General.

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of any incorrect assembly that could result in the malfunction of the system.

(c) A means must be provided to allow full control movement of all primary flight controls prior to flight, or a means must be provided that will allow the pilot to determine that full control authority is available prior to flight.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.672 Stability augmentation, automatic, and power-operated systems.

If the functioning of stability augmentation or other automatic or power-operated system is necessary to show compliance with the flight characteristics requirements of this part, the system must comply with § 29.671 of this part and the following:

(a) A warning which is clearly distinguishable to the pilot under expected flight conditions without requiring the pilot's attention must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system which could result in an unsafe condition if the pilot is unaware of the failure. Warning systems must not activate the control systems.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must allow initial counteraction of failures without requiring exceptional pilot skill or strength, by overriding the failure by moving the flight controls in the normal sense, and by deactivating the failed system.

(c) It must be shown that after any single failure of the stability augmentation system or any other automatic or power-operated system—

(1) The rotorcraft is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved operating limitations;

not impaired below a level needed to allow continued safe flight and landing.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.673 Primary flight controls.

Primary flight controls are those used by the pilot for immediate control of pitch, roll, yaw, and vertical motion of the rotorcraft.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.674 Interconnected controls.

Each primary flight control system must provide for safe flight and landing and operate independently after a malfunction, failure, or jam of any auxiliary interconnected control.

(Amdt. 29–30, Eff. 4/5/90)

§ 29.675 Stops.

(a) Each control system must have stops that positively limit the range of motion of the pilot's controls.

(b) Each stop must be located in the system so that the range of travel of its control is not appreciably affected by—

(1) Wear;

(2) Slackness; or

(3) Takeup adjustments.

(c) Each stop must be able to withstand the loads corresponding to the design conditions for the system.

(d) For each main rotor blade—

(1) Stops that are appropriate to the blade design must be provided to limit travel of the blade about its hinge points; and

(2) There must be means to keep the blade from hitting the droop stops during any operation other than starting and stopping the rotor.

(Amdt. 29–17, Eff. 12/1/78)

§ 29.679 Control system locks.

If there is a device to lock the control system with the rotorcraft on the ground or water, there must be means to—

§ 29.681 Limit load static tests.

(a) Compliance with the limit load requirements of this part must be shown by tests in which—

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included;

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

§ 29.683 Operation tests.

It must be shown by operation tests that, when the controls are operated from the pilot compartment with the control system loaded to correspond with loads specified for the system, the system is free from—

(a) Jamming;

(b) Excessive friction; and

(c) Excessive deflection.

§ 29.685 Control system details.

(a) Each detail of each control system must be designed to prevent jamming, chafing, and interference from cargo, passengers, loose objects, or the freezing of moisture.

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) Cable systems must be designed as follows:

(1) Cables, cable fittings, turnbuckles, splices, and pulleys must be of an acceptable kind.

(2) The design of cable systems must prevent any hazardous change in cable tension throughout the range of travel under any operating conditions and temperature variations.

(3) No cable smaller than one-eighth inch diameter may be used in any primary control system.

fouled.

(6) Pulleys must lie close enough to the plane passing through the cable to prevent the cable from rubbing against the pulley flange.

(7) No fairlead may cause a change in cable direction of more than 3°.

(8) No clevis pin subject to load or motion and retained only by cotter pins may be used in the control system.

(9) Turnbuckles attached to parts having angular motion must be installed to prevent binding throughout the range of travel.

(10) There must be means for visual inspection at each fairlead, pulley, terminal, and turnbuckle.

(e) Control system joints subject to angular motion must incorporate the following special factors with respect to the ultimate bearing strength of the softest material used as a bearing:

(1) 3.33 for push-pull systems other than ball and roller bearing systems.

(2) 2.0 for cable systems.

(f) For control system joints, the manufacturer's static, non-Brinell rating of ball and roller bearings may not be exceeded.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.687 Spring devices.

(a) Each control system spring device whose failure could cause flutter or other unsafe characteristics must be reliable.

(b) Compliance with paragraph (a) of this section must be shown by tests simulating service conditions.

§ 29.691 Autorotation control mechanism.

Each main rotor blade pitch control mechanism must allow rapid entry into autorotation after power failure.

§ 29.695 Power boost and power-operated control system.

(a) If a power boost or power-operated control system is used, an alternate system must be immediately available that allows continued safe flight and landing in the event of—

as valves, lines, and actuators.

(c) The failure of mechanical parts (such as piston rods and links), and the jamming of power cylinders, must be considered unless they are extremely improbable.

LANDING GEAR

§ 29.723 Shock absorption tests.

The landing inertia load factor and the reserve energy absorption capacity of the landing gear must be substantiated by the tests prescribed in §§ 29.725 and 29.727, respectively. These tests must be conducted on the complete rotorcraft or on units consisting of wheel, tire, and shock absorber in their proper relation.

§ 29.725 Limit drop test.

The limit drop test must be conducted as follows:

(a) The drop height must be at least 8 inches.

(b) If considered, the rotor lift specified in § 29.473(a) must be introduced into the drop test by appropriate energy absorbing devices or by the use of an effective mass.

(c) Each landing gear unit must be tested in the attitude simulating the landing condition that is most critical from the standpoint of the energy to be absorbed by it.

(d) When an effective mass is used in showing compliance with paragraph (b) of this section, the following formulae may be used instead of more rational computations.

$$W_e = W\left[\frac{h+(1-L)d}{h+d}\right]\text{; and } n = n_j\frac{W_e}{W} + L$$

where—

W_e=the effective weight to be used in the drop test (lbs).

$W=W_M$ for main gear units (lbs.), equal to the static reaction on the particular unit with the rotorcraft in the most critical attitude. A rational method may be used in computing a main gear static reaction, taking into consideration the moment arm between the main wheel reaction and the rotorcraft center of gravity.

$W=W_N$ for nose gear units (lbs.), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the rotorcraft acts at the acts at the center of gravity and exerts a force of 1g downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions.

h=specified free drop height (inches).

L=ratio of assumed rotor lift to the rotorcraft weight.

d=deflection under impact of the tire (at the proper inflation pressure) plus the vertical component of the axle travel (inches) relative to the drop mass.

n=limit inertia load factor.

n_j=the load factor developed, during impact, on the mass used in the drop test (i.e., the acceleration dv/dt *in* g's recorded in the drop test plus 1.0).

(Amdt. 29–3, Eff. 2/25/68)

§ 29.727 Reserve energy absorption drop test.

The reserve energy absorption drop test must be conducted as follows:

(a) The drop height must be 1.5 times that specified in § 29.725(a).

(b) Rotor lift, where considered in a manner similar to that prescribed in § 29.725(b), may not exceed 1.5 times the lift allowed under that paragraph.

(c) The landing gear must withstand this test without collapsing. Collapse of the landing gear occurs when a member of the nose, tail, or main gear will not support the rotorcraft in the proper attitude or allows the rotorcraft structure, other than landing gear and external accessories, to impact the landing surface.

(Amdt. 29–30, Eff. 4/5/90)

§ 29.729 Retracting mechanism.

For rotorcraft with retractable landing gear, the following apply:

(a) *Loads.* The landing gear, retracting mechanism, wheel well doors, and supporting structure must be designed for—

(1) The loads occurring in any maneuvering condition with the gear retracted;

(2) The combined friction, inertia, and air loads occurring during retraction and extension at any airspeed up to the design maximum landing gear operating speed; and

(3) The flight loads, including those in yawed flight, occurring with the gear extended at any airspeed up to the design maximum landing gear extended speed.

mal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy.

(d) *Operation tests.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator.* There must be means to indicate to the pilot when the gear is secured in the extreme positions.

(f) *Control.* The location and operation of the retraction control must meet the requirements of §§ 29.777 and 29.779.

(g) *Landing gear warning.* An aural or equally effective landing gear warning device must be provided that functions continuously when the rotorcraft is in a normal landing mode and the landing gear is not fully extended and locked. A manual shutoff capability must be provided for the warning device and the warning system must automatically reset when the rotorcraft is no longer in the landing mode.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.731 Wheels.

(a) Each landing gear wheel must be approved.

(b) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with—

(1) Maximum weight; and

(2) Critical center of gravity.

(c) The maximum limit load rating of each wheel must equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this part.

§ 29.733 Tires.

Each landing gear wheel must have a tire—

(a) That is a proper fit on the rim of the wheel; and

(b) Of a rating that is not exceeded under—

(1) The design maximum weight;

(2) A load on each main wheel tire equal to the static ground reaction corresponding to the critical center of gravity; and

and main wheels according to the principles of statics with the drag reaction at the ground applied only at wheels with brakes.

(c) Each tire installed on a retractable landing gear system must, at the maximum size of the tire type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent contact between the tire and any part of the structure or systems.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.735 Brakes.

For rotorcraft with wheel-type landing gear, a braking device must be installed that is—

(a) Controllable by the pilot;

(b) Usable during power-off landings; and

(c) Adequate to—

(1) Counteract any normal unbalanced torque when starting or stopping the rotor; and

(2) Hold the rotorcraft parked on a 10 degree slope on a dry, smooth pavement.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.737 Skis.

(a) The maximum limit load rating of each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of this part.

(b) There must be a stabilizing means to maintain the ski in an appropriate position during flight. This means must have enough strength to withstand the maximum aerodynamic and inertia loads on the ski.

FLOATS AND HULLS

§ 29.751 Main float buoyancy.

(a) For main floats, the buoyancy necessary to support the maximum weight of the rotorcraft in fresh water must be exceeded by—

(1) 50 percent, for single floats; and

(2) 60 percent, for multiple floats.

(b) Each main float must have enough watertight compartments so that, with any single main float compartment flooded, the mainfloats will pro-

to withstand—

(1) The maximum pressure differential that might be developed at the maximum altitude for which certification with the float is requested; and

(2) The vertical loads prescribed in § 29.521(a), distributed along the length of the bag over three-quarters of its projected area.

(b) *Rigid floats.* Each rigid float must be able to withstand the vertical, horizontal and side loads prescribed in § 29.521. An appropriate load distribution under critical conditions must be used.

§ 29.755 Hull buoyancy.

Water-based and amphibian rotorcraft. The hull and auxiliary floats, if used, must have enough watertight compartments so that, with any single compartment of the hull or auxiliary floats flooded, the buoyancy of the hull and auxiliary floats, and wheel tires if used, provides a margin of positive water stability great enough to minimize the probability of capsizing the rotorcraft for the worst combination of wave heights and surface winds for which approval is desired.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–30, Eff. 4/5/90)

§ 29.757 Hull and auxiliary float strength.

The hull, and auxiliary floats if used, must withstand the water loads prescribed by § 29.519 with a rational and conservative distribution of local and distributed water pressures over the hull and float bottom.

(Amdt. 29–3, Eff. 2/25/68)

PERSONNEL AND CARGO ACCOMMODATIONS

§ 29.771 Pilot compartment.

For each pilot compartment—

(a) The compartment and its equipment must allow each pilot to perform his duties without unreasonable concentration or fatigue;

(b) If there is provision for a second pilot, the rotorcraft must be controllable with equal safety

(d) Inflight leakage of rain or snow that could distract the crew or harm the structure must be prevented.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–24, Eff. 12/6/84)

§ 29.773 Pilot compartment view.

(a) *Nonprecipitation conditions.* For nonprecipitation conditions, the following apply:

(1) Each pilot compartment must be arranged to give the pilots a sufficiently extensive, clear, and undistorted view for safe operation.

(2) Each pilot compartment must be free of glare and reflection that could interfere with the pilot's view. If certification for night operation is requested, this must be shown by night flight tests.

(b) *Precipitation conditions.* For precipitation conditions, the following apply:

(1) Each pilot must have a sufficiently extensive view for safe operation—

(i) In heavy rain at forward speeds up to V_H; and

(ii) In the most severe icing condition for which certification is requested.

(2) The first pilot must have a window that—

(i) Is openable under the conditions prescribed in paragraph (b)(1) of this section; and

(ii) Provides the view prescribed in that paragraph.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.775 Windshield and windows.

Windshields and windows must be made of material that will not break into dangerous fragments.

(Amdt. 29–31, Eff. 10/22/90)

§ 29.777 Cockpit controls.

Cockpit controls must be—

(a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and

(b) Located and arranged with respect to the pilot's seats so that there is full and unrestricted movement of each control without interference from

ments and actuation.

(a) Flight controls, including the collective pitch control, must operate with a sense of motion which corresponds to the effect on the rotorcraft.

(b) Twist-grip engine power controls must be designed so that, for lefthand operation, the motion of the pilot's hand is clockwise to increase power when the hand is viewed from the edge containing the index finger. Other engine power controls, excluding the collective control, must operate with a forward motion to increase power.

(c) Normal landing gear controls must operate downward to extend the landing gear.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.783 Doors.

(a) Each closed cabin must have at least one adequate and easily accessible external door.

(b) Each external door must be located, and appropriate operating procedures must be established, to ensure that persons using the door will not be endangered by the rotors, propellers, engine intakes, and exhausts when the operating procedures are used.

(c) There must be means for locking crew and external passenger doors and for preventing their opening in flight inadvertently or as a result of mechanical failure. It must be possible to open external doors from inside and outside the cabin with the rotorcraft on the ground even though persons may be crowded against the door on the inside of the rotorcraft. The means of opening must be simple and obvious and so arranged and marked that it can be readily located and operated.

(d) There must be reasonable provisions to prevent the jamming of any external door in a minor crash as a result of fuselage deformation under the following ultimate inertial forces except for cargo or service doors not suitable for use as an exit in an emergency:

(1) Upward—1.5g.

(2) Forward—4.0g.

(3) Sideward—2.0g.

(4) Downward—4.0g.

(e) There must be means for direct visual inspection of the locking mechanism by crewmembers to determine whether the external doors (including opening when the primary latching mechanism fails. If the door does not meet the requirements of paragraph (c) of this section with this device in place, suitable operating procedures must be established to prevent the use of the device during takeoff and landing.

(g) If an integral stair is installed in a passenger entry door that is qualified as a passenger emergency exit, the stair must be designed so that under the following conditions the effectiveness of passenger emergency egress will not be impaired:

(1) The door, integral stair, and operating mechanism have been subjected to the inertia forces specified in paragraph (d) of this section, acting separately relative to the surrounding structure.

(2) The rotorcraft is in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs, or primary members, as applicable, of the landing gear.

(h) Nonjettisonable doors used as ditching emergency exits must have means to enable them to be secured in the open position and remain secure for emergency egress in sea state conditions prescribed for ditching.

(Amdt. 29–20, Eff. 10/14/80); (Amdt. 29–29, Eff. 12/13/89); (Amdt. 29–30, Eff. 4/5/90); (Amdt. 29–31, Eff. 10/22/90)

§ 29.785 Seats, safety belts, and harnesses.

(a) Each seat, safety belt, harness, and adjacent part of the rotorcraft at each station designated for occupancy during takeoff and landing must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces and must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertial factors specified in § 29.561(b) and dynamic conditions specified in § 29.562.

(b) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object, except as provided for in § 29.562(c)(5). A shoulder harness (upper torso restraint), in combination with the safety belt, constitutes a torso restraint system as defined in TSO–C114.

(c) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot when seated with safety belt and shoulder harness fastened to perform all functions necessary for flight operations. There must be a means to secure belt and harness when not in use to prevent interference with the operation of the rotorcraft and with rapid egress in an emergency.

(d) If seat backs do not have a firm handhold, there must be hand grips or rails along each aisle to let the occupants steady themselves while using the aisle in moderately rough air.

(e) Each projecting object that would injure persons seated or moving about in the rotorcraft in normal flight must be padded.

(f) Each seat and its supporting structure must be designed for an occupant weight of at least 170 pounds, considering the maximum load factors, inertial forces, and reactions between the occupant, seat, and safety belt or harness corresponding with the applicable flight and ground-load conditions, including the emergency landing conditions of § 29.561(b). In addition—

(1) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in § 29.397; and

(2) The inertial forces prescribed in § 29.561(b) must be multiplied by a factor of 1.33 in determining the strength of the attachment of—

(i) Each seat to the structure; and

(ii) Each safety belt or harness to the seat or structure.

(g) When the safety belt and shoulder harness are combined, the rated strength of the safety belt and shoulder harness may not be less than that corresponding to the inertial forces specified in § 29.561(b), considering the occupant weight of at least 170 pounds, considering the dimensional characteristics of the restraint system installation, and using a distribution of at least a 60-percent load to the safety belt and at least a 40-percent load to the shoulder harness. If the safety belt is capable of being used without the shoulder harness, the inertial forces specified must be met by the safety belt alone.

(h) When a headrest is used, the headrest and its supporting structure must be designed to resist the inertia forces specified in § 29.561, with a 1.33 fitting factor and a head weight of at least 13 pounds.

of § 29.562; otherwise, the system must remain intact and must not interfere with rapid evacuation of the rotorcraft.

(k) For purposes of this section, a litter is defined as a device designed to carry a nonambulatory person, primarily in a recumbent position, into and on the rotorcraft. Each berth or litter must be designed to withstand the load reaction of an occupant weight of at least 170 pounds when the occupant is subjected to the forward inertial factors specified in § 29.561(b). A berth or litter installed within 15° or less of the longitudinal axis of the rotorcraft must be provided with a padded endboard, cloth diaphragm, or equivalent means that can withstand the forward load reaction. A berth or litter oriented greater than 15° with the longitudinal axis of the rotorcraft must be equipped with appropriate restraints, such as straps or safety belts, to withstand the forward reaction. In addition—

(1) The berth or litter must have a restraint system and must not have corners or other protuberances likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) The berth or litter attachment and the occupant restraint system attachments to the structure must be designed to withstand the critical loads resulting from flight and ground load conditions and from the conditions prescribed in § 29.561(b).

(Amdt. 29–24, Eff. 12/6/84); (Amdt. 29–29, Eff. 12/13/89)

§ 29.787 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, except the emergency landing conditions of § 29.561.

(b) There must be means to prevent the contents of any compartment from becoming a hazard by shifting under the loads specified in paragraph (a) of this section.

(c) Under the emergency landing conditions of § 29.561, cargo and baggage compartments must—

by paragraph (b) of this section. Sufficient strength must be provided for the maximum authorized weight of cargo and baggage at the critical loading distribution.

(d) If cargo compartment lamps are installed, each lamp must be installed so as to prevent contact between lamp bulb and cargo.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–31, Eff. 10/22/90)

§ 29.801 Ditching.

(a) If certification with ditching provisions is requested, the rotorcraft must meet the requirements of this section and §§ 29.807(d), 29.1411 and 29.1415.

(b) Each practicable design measure, compatible with the general characteristics of the rotorcraft, must be taken to minimize the probability that in an emergency landing on water, the behavior of the rotorcraft would cause immediate injury to the occupants or would make it impossible for them to escape.

(c) The probable behavior of the rotorcraft in a water landing must be investigated by model tests or by comparison with rotorcraft of similar configuration for which the ditching characteristics are known. Scoops, flaps, projections, and any other factors likely to affect the hydrodynamic characteristics of the rotorcraft must be considered.

(d) It must be shown that, under reasonably probable water conditions, the flotation time and trim of the rotorcraft will allow the occupants to leave the rotorcraft and enter the liferafts required by § 29.1415. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowances must be made for probable structural damage and leakage. If the rotorcraft has fuel tanks (with fuel jettisoning provisions) that can reasonably be expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(e) Unless the effects of the collapse of external doors and windows are accounted for in the investigation of the probable behavior of the rotorcraft in a water landing (as prescribed in paragraphs (c) and (d) of this section), the external doors and means for rapid evacuation in a crash landing, with the landing gear (1) extended and (2) retracted, considering the possibility of fire.

(b) Passenger entrance, crew, and service doors may be considered as emergency exits if they meet the requirements of this section and of §§ 29.805 through 29.815.

(c) [Reserved]

(d) Except as provided in paragraph (e) of this section, the following categories of rotorcraft must be tested in accordance with the requirements of appendix D of this part to demonstrate that the maximum seating capacity, including the crewmembers required by the operating rules, can be evacuated from the rotorcraft to the ground within 90 seconds:

(1) Rotorcraft with a seating capacity of more than 44 passengers.

(2) Rotorcraft with all of the following:

(i) Ten or more passengers per passenger exit as determined under § 29.807(b).

(ii) No main aisle, as described in § 29.815, for each row of passenger seats.

(iii) Access to each passenger exit for each passenger by virtue of design features of seats, such as folding or break-over seat backs or folding seats.

(e) A combination of analysis and tests may be used to show that the rotorcraft is capable of being evacuated within 90 seconds under the conditions specified in § 29.803(d) if the Administrator finds that the combination of analysis and test will provide data, with respect to the emergency evacuation capability of the rotorcraft, equivalent to that which would be obtained by actual demonstration.

(Amdt. 29–3, Eff. 2/25/68); [(Amdt. 29–30, Eff. 4/5/90)]

§ 29.805 Flight crew emergency exits.

(a) For rotorcraft with passenger emergency exits that are not convenient to the flight crew, there must be flight crew emergency exits, on both sides of the rotorcraft or as a top hatch, in the flight crew area.

(b) Each flight crew emergency exit must be of sufficient size and must be located so as to

5/90)

§ 29.807 Passenger emergency exits.

(a) *Type.* For the purpose of this part, the types of passenger emergency exit are as follows:

(1) *Type I.* This type must have a rectangular opening of not less than 24 inches wide by 48 inches high, with corner radii not greater than one-third the width of the exit, in the passenger area in the side of the fuselage at floor level and as far away as practicable from areas that might become potential fire hazards in a crash.

(2) *Type II.* This type is the same as Type I, except that the opening must be at least 20 inches wide by 44 inches high.

(3) *Type III.* This type is the same as Type I, except that—

(i) The opening must be at least 20 inches wide by 36 inches high; and

(ii) The exits need not be at floor level.

(4) *Type IV.* This type must have a rectangular opening of not less than 19 inches wide by 26 inches high, with corner radii not greater than one-third the width of the exit, in the side of the fuselage with a step-up inside the rotorcraft of not more than 29 inches.

Openings with dimensions larger than those specified in this section may be used, regardless of shape, if the base of the opening has a flat surface of not less than the specified width.

(b) *Passenger emergency exits; side-of-fuselage.* Emergency exits must be accessible to the passengers and, except as provided in paragraph (d) of this section, must be provided in accordance with the following table:

Passenger seating capacity	Emergency exits for each side of the fuselage			
	Type I	Type II	Type III	Type IV
1 through 10	....	....	....	1
11 through 19	....	....	1 or	2
20 through 39	....	1	....	1
40 through 59	1	....	....	1
60 through 79	1	....	1 or	2

to rest on its side in a crash landing must be extremely remote.

(d) *Ditching emergency exits for passengers.* If certification with ditching provisions is requested, ditching emergency exits must be provided in accordance with the following requirements and must be proven by test, demonstration, or analysis unless the emergency exits required by paragraph (b) of this section already meet these requirements.

(1) For rotorcraft that have a passenger seating configuration, excluding pilots seats, of nine seats or less, one exit above the waterline in each side of the rotorcraft, meeting at least the dimensions of a Type IV exit.

(2) For rotorcraft that have a passenger seating configuration, excluding pilots seats, of 10 seats or more, one exit above the waterline in a side of the rotorcraft meeting at least the dimensions of a Type III exit, for each unit (or part of a unit) of 35 passenger seats, but no less than two such exits in the passenger cabin, with one on each side of the rotorcraft. However, where it has been shown through analysis, ditching demonstrations, or any other tests found necessary by the Administrator, that the evacuation capability of the rotorcraft during ditching is improved by the use of larger exits, or by other means, the passenger seat to exit ratio may be increased.

(3) Flotation devices, whether stowed or deployed, may not interfere with or obstruct the exits.

(e) *Ramp exits.* One Type I exit only, or one Type II exit only, that is required in the side of the fuselage under paragraph (b) of this section, may be installed instead in the ramp of floor ramp rotorcraft if—

(1) Its installation in the side of the fuselage is impractical; and

(2) Its installation in the ramp meets § 29.813.

(f) *Tests.* The proper functioning of each emergency exit must be shown by test.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–30, Eff. 4/5/90)

(c) The means of opening each emergency exit must be simple and obvious and may not require exceptional effort.

(d) There must be means for locking each emergency exit and for preventing opening in flight inadvertently or as a result of mechanical failure.

(e) There must be means to minimize the probability of the jamming of any emergency exit in a minor crash landing as a result of fuselage deformation under the ultimate inertial forces in § 29.783(d).

(f) Except as provided in paragraph (h) of this section, each land-based rotorcraft emergency exit must have an approved slide as stated in paragraph (g) of this section, or its equivalent, to assist occupants in descending to the ground from each floor level exit and an approved rope, or its equivalent, for all other exits, if the exit threshold is more that 6 feet above the ground—

(1) With the rotorcraft on the ground and with the landing gear extended;

(2) With one or more legs or part of the landing gear collapsed, broken, or not extended; and

(3) With the rotorcraft resting on its side, if required by § 29.803(d).

(g) The slide for each passenger emergency exit must be a self-supporting slide or equivalent, and must be designed to meet the following requirements:

(1) It must be automatically deployed, and deployment must begin during the interval between the time the exit opening means is actuated from inside the rotorcraft and the time the exit is fully opened. However, each passenger emergency exit which is also a passenger entrance door or a service door must be provided with means to prevent deployment of the slide when the exit is opened from either the inside or the outside under nonemergency conditions for normal use.

(2) It must be automatically erected within 10 seconds after deployment is begun.

(3) It must be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occu-

(5) Each slide installation must be qualified by five consecutive deployment and inflation tests conducted (per exit) without failure, and at least three tests of each such five-test series must be conducted using a single representative sample of the device. The sample devices must be deployed and inflated by the system's primary means after being subjected to the inertia forces specified in § 29.561(b). If any part of the system fails or does not function properly during the required tests, the cause of the failure or malfunction must be corrected by positive means and after that, the full series of five consecutive deployment and inflation tests must be conducted without failure.

(h) For rotorcraft having 30 or fewer passenger seats and having an exit threshold more than 6 feet above the ground, a rope or other assist means may be used in place of the slide specified in paragraph (f) of this section, provided an evacuation demonstration is accomplished as prescribed in § 29.803(d) or (e).

(i) If a rope, with its attachment, is used for compliance with paragraph (f), (g), or (h) of this section, it must—

(1) Withstand a 400-pound static load; and

(2) Attach to the fuselage structure at or above the top of the emergency exit opening, or at another approved location if the stowed rope would reduce the pilot's view in flight.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–29, Eff. 12/13/89); (Amdt. 29–30, Eff. 4/5/90)

§ 29.811 Emergency exit marking.

(a) Each passenger emergency exit, its means of access, and its means of opening must be conspicuously marked for the guidance of occupants using the exits in daylight or in the dark. Such markings must be designed to remain visible for rotorcraft equipped for overwater flights if the rotorcraft is capsized and the cabin is submerged.

(b) The identity and location of each passenger emergency exit must be recognizable from a distance equal to the width of the cabin.

(c) The location of each passenger emergency exit must be indicated by a sign visible to occupants fore and aft vision along the passenger cabin, to indicate emergency exits beyond and obscured by it, except that if this is not possible the sign may be placed at another appropriate location.

(d) Each passenger emergency exit marking and each locating sign must have white letters 1 inch high on a red background 2 inches high, be self or electrically illuminated, and have a minimum luminescence (brightness) of at least 160 microlamberts. The colors may be reversed if this will increase the emergency illumination of the passenger compartment.

(e) The location of each passenger emergency exit operating handle and instructions for opening must be shown—

(1) For each emergency exit, by a marking on or near the exit that is readable from a distance of 30 inches; and

(2) For each Type I or Type II emergency exit with a locking mechanism released by rotary motion of the handle, by—

(i) A red arrow, with a shaft at least three-fourths inch wide and a head twice the width of the shaft, extending along at least 70° of arc at a radius approximately equal to three-fourths of the handle length; and

(ii) The word ''open'' in red letters 1 inch high, placed horizontally near the head of the arrow.

(f) Each emergency exit, and its means of opening, must be marked on the outside of the rotorcraft. In addition, the following apply:

(1) There must be a 2-inch colored band outlining each passenger emergency exit, except small rotorcraft with a maximum weight of 12,500 pounds or less may have a 2-inch colored band outlining each exit release lever or device of passenger emergency exits which are normally used doors.

(2) Each outside marking, including the band, must have color contrast to be readily distinguishable from the surrounding fuselage surface. The contrast must be such that, if the reflectance of the darker color is 15 percent or less, the reflectance of the lighter color must be at least 45 percent. ''Reflectance'' is the ratio of the luminous flux reflected by a body to the luminous

ments for emergency exits of the particular type. Emergency exits need only be marked with the word ''Exit.''

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–24, Eff. 12/6/84); (Amdt. 29–30, Eff. 4/5/90); (Amdt. 29–31, Eff. 10/22/90)

§ 29.812 Emergency lighting.

For transport Category A rotorcraft, the following apply:

(a) A source of light with its power supply independent of the main lighting system must be installed to—

(1) Illuminate each passenger emergency exit marking and locating sign; and

(2) Provide enough general lighting in the passenger cabin so that the average illumination, when measured at 40-inch intervals at seat armrest height on the center line of the main passenger aisle, is at least 0.05 foot-candle.

(b) Exterior emergency lighting must be provided at each emergency exit. The illumination may not be less than 0.05 foot-candle (measured normal to the direction of incident light) for minimum width on the ground surface, with landing gear extended, equal to the width of the emergency exit where an evacuee is likely to make first contact with the ground outside the cabin. The exterior emergency lighting may be provided by either interior or exterior sources with light intensity measurements made with the emergency exits open.

(c) Each light required by paragraph (a) or (b) of this section must be operable manually from the cockpit station and from a point in the passenger compartment that is readily accessible. The cockpit control device must have an ''on,'' ''off,'' and ''armed'' position so that when turned on at the cockpit or passenger compartment station or when armed at the cockpit station, the emergency lights will either illuminate or remain illuminated upon interruption of the rotorcraft's normal electric power.

(d) Any means required to assist the occupants in descending to the ground must be illuminated so that the erected assist means is visible from the rotorcraft.

(1) The assist means must be provided with an illumination of not less than 0.03 foot-candle (measured normal to the direction of the incident light) at the ground end of the erected assist means where an evacuee using the established escape route would normally make first contact with the ground, with the rotorcraft in each of the attitudes corresponding to the collapse of one or more legs of the landing gear.

(2) If the emergency lighting subsystem illuminating the assist means is independent of the rotorcraft's main emergency lighting system, it—

(i) Must automatically be activated when the assist means is erected;

(ii) Must provide the illumination required by paragraph (d)(1); and

(iii) May not be adversely affected by stowage.

(e) The energy supply to each emergency lighting unit must provide the required level of illumination for at least 10 minutes at the critical ambient conditions after an emergency landing.

(f) If storage batteries are used as the energy supply for the emergency lighting system, they may be recharged from the rotorcraft's main electrical power system provided the charging circuit is designed to preclude inadvertent battery discharge into charging circuit faults.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.813 Emergency exit access.

(a) Each passageway between passenger compartments, and each passageway leading to Type I and Type II emergency exits, must be—

(1) Unobstructed; and

(2) At least 20 inches wide.

(b) For each emergency exit covered by § 29.809(f), there must be enough space adjacent to that exit to allow a crewmember to assist in the evacuation of passengers without reducing the unobstructed width of the passageway below that required for that exit.

(c) There must be access from each aisle to each Type III and Type IV exit, and

(1) For rotorcraft that have a passenger seating configuration, excluding pilot seats, of 20 or more, the projected opening of the exit provided must not be obstructed by seats, berths, or other protrusions (including seatbacks in any position) for a distance from that exit of not less than the width of the narrowest passenger seat installed on the rotorcraft;

approved.

(2) The kinds and quantities of each extinguishing agent used must be appropriate to the kinds of fires likely to occur where that agent is used.

(3) Each extinguisher for use in a personnel compartment must be designed to minimize the hazard of toxic gas concentrations.

(b) *Built-in fire extinguishers.* If a built-in fire extinguishing system is required—

(1) The capacity of each system, in relation to the volume of the compartment where used and the ventilation rate, must be adequate for any fire likely to occur in that compartment.

(2) Each system must be installed so that—

(i) No extinguishing agent likely to enter personnel compartments will be present in a quantity that is hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

§ 29.815 Main aisle width.

The main passenger aisle width between seats must equal or exceed the values in the following table:

Passenger seating capacity	Minimum main passenger aisle width	
	Less than 25 inches from floor	25 inches and more from floor
	Inches	*Inches*
10 or less	12*	15
11 through 19	12	20
20 or more	15	20

*A narrow width not less than 9 inches may be approved when substantiated by tests found necessary by the Administrator.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.831 Ventilation.

(a) Each passenger and crew compartment must be ventilated, and each crew compartment must have enough fresh air (but not less than 10 cu. ft. per minute per crewmember) to let crewmembers perform their duties without undue discomfort or fatigue.

(b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases of vapors.

(c) The concentration of carbon monoxide may not exceed one part in 20,000 parts of air during forward flight. If the concentration exceeds this value under other conditions, there must be suitable operating restrictions.

(d) There must be means to ensure compliance with paragraphs (b) and (c) of this section under any reasonably probable failure of any ventilating, heating, or other system or equipment.

§ 29.833 Heaters.

Each combustion heater must be approved.

§ 29.853 Compartment interiors.

For each compartment to be used by the crew or passengers—

(a) The materials (including finishes or decorative surfaces applied to the materials) must meet the following test criteria as applicable:

(1) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments (other than underseat stowage compartments and compartments for stowing small items such as magazines and maps) must be self-extinguishing when tested vertically in accordance with the applicable portions of appendix F of part 25 of this chapter, or other approved equivalent methods. The average burn length may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(2) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather,

structed of materials not covered in paragraph (a)(3) of this section, must be self extinguishing when tested vertically in accordance with the applicable portion of appendix F of part 25 of this chapter, or other approved equivalent methods. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

(3) Acrylic windows and signs, parts constructed in whole or in part of elasto-metric materials, edge lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tiedown equipment, including containers, bins, pallets, etc., used in passenger or crew compartments, may not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of appendix F of part 25 of this chapter, or other approved equivalent methods.

(4) Except for electrical wire and cable insulation, and for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that the Administrator finds would not contribute significantly to the propagation of a fire, materials in items not specified in paragraphs (a)(1), (a)(2), or (a)(3) of this section may not have a burn rate greater than 4 inches per minute when tested horizontally in accordance with the applicable portions of appendix F of part 25 of this chapter, or other approved equivalent methods.

(b) In addition to meeting the requirements of paragraph (a)(2), seat cushions, except those on flight crewmember seats, must meet the test requirements of part II of appendix F of part 25 of this chapter, or equivalent.

(c) If smoking is to be prohibited, there must be a placard so stating, and if smoking is to be allowed—

(1) There must be an adequate number of self-contained removable ashtrays; and

(2) Where the crew compartment is separated from the passenger compartment, there must be

(ii) Be so constructed that the crew can turn the illumination on and off.

(d) Each receptacle for towels, paper, or waste must be at least fire-resistant and must have means for containing possible fires.

(e) There must be a hand fire extinguisher for the flight crewmembers; and

(f) At least the following number of hand fire extinguishers must be conveniently located in passenger compartments:

Passenger capacity:	*Fire extinguishers*
7 through 30	1
31 through 60	2
61 or more	3

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–18, Eff. 3/6/80); (Amdt. 29–23, Eff. 11/26/84)

§ 29.855 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be constructed of or lined with materials in accordance with the following:

(1) For accessible and inaccessible compartments not occupied by passengers or crew, the material must be at least fire resistant.

(2) Materials must meet the requirements in § 29.853(a)(1), (a)(2), and (a)(3) for cargo or baggage compartments in which—

(i) The presence of a compartment fire would be easily discovered by a crewmember while at the crewmember's station;

(ii) Each part of the compartment is easily accessible in flight;

(iii) The compartment has a volume of 200 cubic feet or less; and

(iv) Notwithstanding § 29.1439(a), protective breathing equipment is not required.

(b) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that—

(1) They cannot be damaged by the movement of cargo in the compartment; and

is not sealed so as to contain cargo compartment fires completely without endangering the safety of a rotorcraft or its occupants must be designed, or must have a device, to ensure detection of fires or smoke by a crewmember while at his station and to prevent the accumulation of harmful quantities of smoke, flame, extinguishing agents, and other noxious gases in any crew or passenger compartment. This must be shown in flight.

(e) For rotorcraft used for the carriage of cargo only, the cabin area may be considered a cargo compartment and, in addition to paragraphs (a) through (d) of this section, the following apply:

(1) There must be means to shut off the ventilating airflow to or within the compartment. Controls for this purpose must be accessible to the flight crew in the crew compartment.

(2) Required crew emergency exits must be accessible under all cargo loading conditions.

(3) Sources of heat within each compartment must be shielded and insulated to prevent igniting the cargo.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–24, Eff. 12/6/84); (Amdt. 29–30, Eff. 4/5/90)

§ 29.859 Combustion heater fire protection.

(a) *Combustion heater fire zones.* The following combustion heater fire zones must be protected against fire under the applicable provisions of §§ 29.1181 through 29.1191, and 29.1195 through 29.1203:

(1) The region surrounding any heater, if that region contains any flammable fluid system components (including the heater fuel system), that could—

(i) Be damaged by heater malfunctioning; or

(ii) Allow flammable fluids or vapors to reach the heater in case of leakage.

(2) Each part of any ventilating air passage that—

(i) Surrounds the combustion chamber; and

(ii) Would not contain (without damage to other rotorcraft components) any fire that may occur within the passage.

that any fire originating in the heater can be contained in the duct; and

(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be so constructed or isolated from that system that the malfunctioning of any component of that system cannot introduce flammable fluids or vapors into the ventilating airstream.

(c) *Combustion air ducts.* Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation. In addition—

(1) No combustion air duct may communicate with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunction of the heater or its associated components; and

(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(d) *Heater controls; general.* There must be means to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(e) *Heater safety controls.* For each combustion heater, safety control means must be provided as follows:

(1) Means independent of the components provided for the normal continuous control of air temperature, airflow, and fuel flow must be provided, for each heater, to automatically shut off the ignition and fuel supply of that heater at a point remote from that heater when any of the following occurs:

(i) The heat exchanger temperature exceeds safe limits.

(ii) The ventilating air temperature exceeds safe limits.

(iii) The combustion airflow becomes inadequate for safe operation.

(iv) The ventilating airflow becomes inadequate for safe operation.

(2) The means of complying with paragraph (e)(1) of this section for any individual heater must—

for safe operation has been shut off by the automatic means prescribed in paragraph (e)(1) of this section.

(f) *Air intakes.* Each combustion and ventilating air intake must be where no flammable fluids or vapors can enter the heater system under any operating condition—

(1) During normal operation; or

(2) As a result of the malfunction of any other component.

(g) *Heater exhaust.* Each heater exhaust system must meet the requirements of §§ 29.1121 and 29.1123. In addition—

(1) Each exhaust shroud must be sealed so that no flammable fluids or hazardous quantities of vapors can reach the exhaust systems through joints; and

(2) No exhaust system may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(h) *Heater fuel systems.* Each heater fuel system must meet the powerplant fuel system requirements affecting safe heater operation. Each heater fuel system component in the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

(i) *Drains.* There must be means for safe drainage of any fuel that might accumulate in the combustion chamber or the heat exchanger. In addition—

(1) Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts; and

(2) Each drain must be protected against hazardous ice accumulation under any operating condition.

(Amdt. 29–2, Eff. 6/4/67)

§ 29.861 Fire protection of structure, controls, and other parts.

Each part of the structure, controls, and the rotor mechanism, and other parts essential to controlled landing and (for category A) flight that would be affected by powerplant fires must be isolated under § 29.1191, or must be—

§ 29.863 Flammable fluid fire protection.

(a) In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of rotorcraft components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher), quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapors might escape by leakage of a fluid system must be identified and defined.

(Amdt. 29–17, Eff. 12/1/78)

EXTERNAL LOAD ATTACHING MEANS

§ 29.865 External load attaching means.

(a) It must be shown by analysis or test, or both, that the rotorcraft external-load attaching means can withstand a limit static load equal to 2.5, or some lower factor approved under §§ 29.337 through 29.341, multiplied by the maximum external load for which authorization is requested. The load is applied in the vertical direction and in any direction making an angle of 30° with the vertical, except for those directions having a forward compobe exceeded in service.

(b) The external load attaching means for Class B and Class C rotorcraft-load combinations must include a device to enable the pilot to release the external load quickly during flight. This quick-release device, and the means by which it is controlled, must comply with the following:

(1) A control for the quick-release device must be installed on one of the pilot's primary controls and must be designed and located so that it may be operated by the pilot without hazardously limiting his ability to control the rotorcraft during an emergency situation.

(2) In addition, a manual mechanical control for the quick-release device, readily accessible either to the pilot or to another crew member, must be provided.

(3) The quick-release device must function properly with all external loads up to and includ-

not apply to this section except for a failure of the cargo attaching means that results in a hazard to the rotorcraft.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–30, Eff. 4/5/90)

MISCELLANEOUS

§ 29.871 Leveling marks.

There must be reference marks for leveling the rotorcraft on the ground.

§ 29.873 Ballast provisions.

Ballast provisions must be designed and constructed to prevent inadvertent shifting of ballast in flight.

§ 29.877 [Reserved.]

GENERAL

§ 29.901 Installation.

(a) For the purpose of this part, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that—

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant installation—

(1) The installation must comply with—

(i) The installation instructions provided under § 33.5 of this chapter; and

(ii) The applicable provisions of this subpart.

(2) Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested.

(3) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness;

(4) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft; and

(5) Axial and radial expansion of turbine engines may not affect the safety of the installation.

(6) Design precautions must be taken to minimize the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation with the incorrect assembly can be shown to be extremely improbable.

(c) [For each powerplant and auxiliary power unit installation, it must be established that no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the rotorcraft except that the failure of structural elements need not be considered if the probability of any such failure is extremely remote.]

(d) Each auxiliary power unit installation must meet the applicable provisions of this subpart.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–36, Eff. 1/31/96)]

§ 29.903 Engines.

(a) *Engine type certification.* Each engine must have an approved type certificate. Reciprocating engines for use in helicopters must be qualified in accordance with § 33.49(d) of this chapter or be otherwise approved for the intended usage.

(b) *Category A: Engine isolation.* For each category A rotorcraft, the powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or the failure of any system that can affect any engine, will not—

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action, other than normal pilot action with primary flight controls, by any crewmember to maintain safe operation.

(c) *Category A: Control of engine rotation.* For each category A rotorcraft, there must be a means for stopping the rotation of any engine individually in flight, except that, for turbine engine installations, the means for stopping the engine need be provided only where necessary for safety. In addition—

(1) Each component of the engine stopping system that is located on the engine side of the firewall, and that might be exposed to fire, must be at least fire resistant; or

(2) Duplicate means must be available for stopping the engine and the controls must be where all are not likely to be damaged at the same time in case of fire.

(d) [*Turbine engine installation.* For turbine engine installations—

[(1) Design precautions must be taken to minimize the hazards to the rotorcraft in the event of an engine rotor failure; and

[(2) The powerplant systems associated with engine control devices, systems, and instrumenta-

(2) Except for the in-flight shutdown of all engines, engine restart capability must be demonstrated throughout a flight envelope for the rotorcraft.

(3) Following the in-flight shutdown of all engines, in-flight engine restart capability must be provided.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–22, Eff. 3/26/84); (Amdt. 29–26, Eff. 10/3/88); (Amdt. 29–31, Eff. 10/22/90); [(Amdt. 29–36, Eff. 1/31/96)]

§ 29.907 Engine vibration.

(a) Each engine must be installed to prevent the harmful vibration of any part of the engine or rotorcraft.

(b) The addition of the rotor and the rotor drive system to the engine may not subject the principal rotating parts of the engine to excessive vibration stresses. This must be shown by a vibration investigation.

§ 29.908 Cooling fans.

For cooling fans that are a part of a powerplant installation the following apply:

(a) *Category A.* For cooling fans installed in Category A rotorcraft, it must be shown that a fan blade failure will not prevent continued safe flight either because of damage caused by the failed blade or loss of cooling air.

(b) *Category B.* For cooling fans installed in category B rotorcraft, there must be means to protect the rotorcraft and allow a safe landing if a fan blade fails. It must be shown that—

(1) The fan blade would be contained in the case of a failure;

(2) Each fan is located so that a fan blade failure will not jeopardize safety; or

(3) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force expected in service, limited by either—

(i) The highest rotational speeds achievable under uncontrolled conditions; or

(ii) An overspeed limiting device.

ROTOR DRIVE SYSTEM

§ 29.917 Design.

(a) *General.* The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gear boxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the rotor drive system.

[(b) *Design assessment.* A design assessment must be performed to ensure that the rotor drive system functions safely over the full range of conditions for which certification is sought. The design assessment must include a detailed failure analysis to identify all failures that will prevent continued safe flight or safe landing and must identify the means to minimize the likelihood of their occurrence.]

([c]) *Arrangement.* Rotor drive systems must be arranged as follows:

(1) Each rotor drive system of multi-engine rotorcraft must be arranged so that each rotor necessary for operation and control will continue to be driven by the remaining engines if any engine fails.

(2) For single-engine rotorcraft, each rotor drive system must be so arranged that each rotor necessary for control in autorotation will continue to be driven by the main rotors after disengagement of the engine from the main and auxiliary rotors.

(3) Each rotor drive system must incorporate a unit for each engine to automatically disengage that engine from the main and auxiliary rotors if that engine fails.

(4) If a torque limiting device is used in the rotor drive system, it must be located so as to allow continued control of the rotorcraft when the device is operating.

(5) If the rotors must be phased for intermeshing, each system must provide constant and positive phase relationship under any operating condition.

If there is a means to control the rotation of the rotor drive system independently of the engine, any limitations on the use of that means must be specified, and the control for that means must be guarded to prevent inadvertent operation.

§ 29.923 Rotor drive system and control mechanism tests.

(a) *Endurance tests, general.* Each rotor drive system and rotor control mechanism must be tested, as prescribed in paragraphs (b) through (n) of this section, for at least 200 hours plus the time required to meet the requirements of paragraphs (b)(2), (b)(3), and (k) of this section. These tests must be conducted as follows:

(1) Ten-hour test cycles must be used, except that the test cycle must be extended to include the OEI test of paragraphs (b)(2) and (k) of this section, if OEI ratings are requested.

(2) The tests must be conducted on the rotorcraft.

(3) The test torque and rotational speed must be—

(i) Determined by the powerplant limitations; and

(ii) Absorbed by the rotors to be approved for the rotorcraft.

(b) *Endurance tests, takeoff run.* The takeoff run must be conducted as follows:

(1) Except as prescribed in paragraphs (b)(2) and (b)(3) of this section, the takeoff torque run must consist of 1 hour of alternate runs of 5 minutes at takeoff torque and the maximum speed for use with takeoff torque, and 5 minutes at as low an engine idle speed as practicable. The engine must be declutched from the rotor drive system, and the rotor brake, if furnished and so intended, must be applied during the first minute of the idle run. During the remaining 4 minutes of the idle run, the clutch must be engaged so that the engine drives the rotors at the minimum practical r.p.m. The engine and the rotor drive system must be accelerated at the maximum rate. When declutching the engine, it must be decelerated rapidly enough to allow the operation of the overrunning clutch.

following apply:

(i) Each run must consist of at least one period of 2½ minutes with takeoff torque and the maximum speed for use with takeoff torque on all engines.

(ii) Each run must consist of at least one period, for each engine in sequence, during which that engine simulates a power failure and the remaining engines are run at the 2½-minutes OEI torque and the maximum speed for use with 2½-minute OEI torque for 2½ minutes.

(3) For multiengine, turbine-powered rotorcraft for which the use of 30-second/2-minute OEI power is requested, the takeoff run must be conducted as prescribed in paragraph (b)(1) of this section except for the following:

(i) [Immediately following any one 5-minute power-on run required by paragraph (b)(1) of this section, simulate a failure for each power source in turn, and apply the maximum torque and the maximum speed for use with 30-second OEI power to the remaining affected drive system power inputs for not less than 30 seconds. Each application of 30-second OEI power must be followed by two applications of the maximum torque and the maximum speed for use with the 2 minute OEI power for not less than 2 minutes each; the second application must follow a period at stabilized continuous or 30 minute OEI power (whichever is requested by the applicant). At least one run sequence must be conducted from a simulated "flight idle" condition. When conducted on a bench test, the test sequence must be conducted following stabilization at takeoff power.]

(ii) For the purpose of this paragraph, an affected power input includes all parts of the rotor drive system which can be adversely affected by the application of higher or asymmetric torque and speed prescribed by the test.

(iii) This test may be conducted on a representative bench test facility when engine limitations either preclude repeated use of this power or would result in premature engine removals during the test. The loads, the vibration frequency, and the methods of application with maximum continuous torque must be conducted as follows:

(1) The main rotor controls must be operated at a minimum of 15 times each hour through the main rotor pitch positions of maximum vertical thrust, maximum forward thrust component, maximum aft thrust component, maximum left thrust component, and maximum right thrust component, except that the control movements need not produce loads or blade flapping motion exceeding the maximum loads of motions encountered in flight.

(2) The directional controls must be operated at a minimum of 15 times each hour through the control extremes of maximum right turning torque, neutral torque as required by the power applied to the main rotor, and maximum left turning torque.

(3) Each maximum control position must be held for at least 10 seconds, and the rate of change of control position must be at least as rapid as that for normal operation.

(d) *Endurance tests; 90 percent of maximum continuous run.* One hour of continuous operation at 90 percent of maximum continuous torque and the maximum speed for use with 90 percent of maximum continuous torque must be conducted.

(e) *Endurance tests; 80 percent of maximum continuous run.* One hour of continuous operation at 80 percent of maximum continuous torque and the minimum speed for use with 80 percent of maximum continuous torque must be conducted.

(f) *Endurance tests; 60 percent of maximum continuous run.* Two hours or, for helicopters for which the use of either 30-minute OEI power or continuous OEI power is requested, 1 hour of continuous operation at 60 percent of maximum continuous torque and the minimum speed for use with 60 percent of maximum continuous torque must be conducted.

(g) *Endurance tests; engine malfunctioning run.* It must be determined whether malfunctioning of components, such as the engine fuel or ignition systems, or whether unequal engine power can cause dynamic conditions detrimental to the drive system. If so, a suitable number of hours of operation must be accomplished under those conditions, 1 hour of which must be included in each cycle,

(h) *Endurance tests; overspeed run.* One hour of continuous operation must be conducted at maximum continuous torque and the maximum power-on overspeed expected in service, assuming that speed and torque limiting devices, if any, function properly.

(i) *Endurance tests; rotor control positions.* When the rotor controls are not being cycled during the tie-down tests, the rotor must be operated, using the procedures prescribed in paragraph (c) of this section, to produce each of the maximum thrust positions for the following percentages of test time (except that the control positions need not produce loads or blade flapping motion exceeding the maximum loads or motions encountered in flight):

(1) For full vertical thrust, 20 percent.

(2) For the forward thrust component, 50 percent.

(3) For the right thrust component, 10 percent.

(4) For the left thrust component, 10 percent.

(5) For the aft thrust component, 10 percent.

(j) *Endurance tests, clutch and brake engagements.* A total of at least 400 clutch and brake engagements, including the engagements of paragraph (b) of this section, must be made during the takeoff torque runs and, if necessary, at each change of torque and speed throughout the test. In each clutch engagement, the shaft on the driven side of the clutch must be accelerated from rest. The clutch engagements must be accomplished at the speed and by the method prescribed by the applicant. During deceleration after each clutch engagement, the engines must be stopped rapidly enough to allow the engines to be automatically disengaged from the rotors and rotor drives. If a rotor brake is installed for stopping the rotor, the clutch, during brake engagements, must be disengaged above 40 percent of maximum continuous rotor speed and the rotors allowed to decelerate to 40 percent of maximum continuous rotor speed, at which time the rotor brake must be applied. If the clutch design does not allow stopping the rotors with the engine running, or if no clutch is provided, the engine must be stopped before each application of the rotor brake, and then immediately be started after the rotors stop.

(k) *Endurance tests, OEI power run.*

a 30-minute period.

(2) *Continuous OEI power run.* For rotorcraft for which the use of continuous OEI power is requested, a run at continuous OEI torque and the maximum speed for use with continuous OEI torque must be conducted as follows: For each engine, in sequence, that engine must be inoperative and the remaining engines must be run for 1 hour.

(3) The number of periods prescribed in paragraph (k)(1) or (k)(2) of this section may not be less than the number of engines, nor may it be less than two.

(l) [Reserved]

(m) Any components that are affected by maneuvering and gust loads must be investigated for the same flight conditions as are the main rotors, and their service lives must be determined by fatigue tests or by other acceptable methods. In addition, a level of safety equal to that of the main rotors must be provided for—

(1) Each component in the rotor drive system whose failure would cause an uncontrolled landing;

(2) Each component essential to the phasing of rotors on multirotor rotorcraft, or that furnishes a driving link for the essential control of rotors in autorotation; and

(3) Each component common to two or more engines on multiengine rotorcraft.

(n) *Special tests.* Each rotor drive system designed to operate at two or more gear ratios must be subjected to special testing for durations necessary to substantiate the safety of the rotor drive system.

(o) Each part tested as prescribed in this section must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results may be conducted.

(p) *Endurance tests; operating lubricants.* To be approved for use in rotor drive and control systems, lubricants must meet the specifications of lubricants used during the tests prescribed by this section. Additional or alternate lubricants may be qualified by equivalent testing or by comparative analysis of lubricant specifications and rotor drive and control system characteristics. In addition—

three 10-hour cycles required by this section must be conducted with the lubricant pressure, at the location prescribed for measurement, not higher than the minimum operating pressure for which approval is requested; and

(3) The test conditions of paragraphs (p)(1) and (p)(2) of this section must be applied simultaneously and must be extended to include operation at any one-engine-inoperative rating for which approval is requested.

(Amdt. 29–1, Eff. 8/12/65); (Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–26, Eff. 10/3/88); (Amdt. 29–31, Eff. 10/22/90); (Amdt. 29–34, Eff. 10/17/94); [(Amdt. 29–40, Eff. 8/8/96)]

§ 29.927 Additional tests.

(a) Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the rotor drive mechanism is safe, must be performed.

(b) If turbine engine torque output to the transmission can exceed the highest engine or transmission torque limit, and that output is not directly controlled by the pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:

(1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, of torque that is at least equal to the lesser of—

(i) The maximum torque used in meeting § 29.923 plus 10 percent; or

(ii) The maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly.

(2) For multiengine rotorcraft under conditions associated with each engine, in turn, becoming inoperative, apply to the remaining transmission torque inputs the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly. Each transmission input must be tested at this maximum torque for at least fifteen minutes.

vent continued safe operation, although not necessarily without damage, at a torque and rotational speed prescribed by the applicant for continued flight, for at least 30 minutes after perception by the flightcrew of the lubrication system failure or loss of lubricant.

(2) *Category B.* The requirements of Category A apply except that the rotor drive system need only be capable of operating under autorotative conditions for a least 15 minutes.

(d) *Overspeed test.* The rotor drive system must be subjected to 50 overspeed runs, each 30 ± 3 seconds in duration, at not less than either the higher of the rotational speed to be expected from an engine control device failure or 105 percent of the maximum rotational speed, including transients, to be expected in service. If speed and torque limiting devices are installed, are independent of the normal engine control, and are shown to be reliable, their rotational speed limits need not be exceeded. These runs must be conducted as follows:

(1) Overspeed runs must be alternated with stabilizing runs of from 1 to 5 minutes duration each at 60 to 80 percent of maximum continuous speed.

(2) Acceleration and deceleration must be accomplished in a period not longer than 10 seconds (except where maximum engine acceleration rate will require more than 10 seconds), and the time for changing speeds may not be deducted from the specified time for the overspeed runs.

(3) Overspeed runs must be made with the rotors in the flattest pitch for smooth operation.

(e) The tests prescribed in paragraphs (b) and (d) of this section must be conducted on the rotorcraft and the torque must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque absorption may be used if the conditions of support and vibration closely simulate the conditions that would exist during a test on the rotorcraft.

(f) Each test prescribed by this section must be conducted without intervening disassembly and, except for the lubrication system failure test required by paragraph (c) of this section, each part

§ 29.931 Shafting critical speed.

(a) The critical speeds of any shafting must be determined by demonstration except that analytical methods may be used if reliable methods of analysis are available for the particular design.

(b) If any critical speed lies within, or close to, the operating ranges for idling, power-on, and autorotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.

(c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.935 Shafting joints.

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

§ 29.939 Turbine engine operating characteristics.

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the rotorcraft and of the engine.

(b) The turbine engine air inlet system may not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

(c) For governor-controlled engines, it must be shown that there exists no hazardous torsional instability of the drive system associated with critical combinations of power, rotational speed, and control displacement.

(Amdt. 29–2, Eff. 6/4/67); (Amdt. 29–12, Eff. 2/1/77) conditions, including the maneuvers for which certification is requested and during which the engine or auxiliary power unit is permitted to be in operation.

(b) Each fuel system must be arranged so that—

(1) No engine or fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80° F. and having 0.75 cc. of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(Amdt. 29–10, Eff. 10/31/74); (Amdt. 29–12, Eff. 2/1/77)

[§ 29.952 Fuel system crash resistance.

[Unless other means acceptable to the Administrator are employed to minimize the hazard of fuel fires to occupants following an otherwise survivable impact (crash landing), the fuel systems must incorporate the design features of this section. These systems must be shown to be capable of sustaining the static and dynamic deceleration loads of this section, considered as ultimate loads acting alone, measured at the system component's center of gravity without structural damage to system components, fuel tanks, or their attachments that would leak fuel to an ignition source.

(a) *Drop test requirements.* Each tank, or the most critical tank, must be drop-tested as follows:

(1) The drop height must be at least 50 feet.

(2) The drop impact surface must be nondeforming.

(3) The tank must be filled with water to 80 percent of the normal, full capacity.

(4) The tank must be enclosed in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank.

(5) The tank must drop freely and impact in a horizontal position ±10°.

and installed to retain its contents under the following ultimate inertial load factors, acting alone.

(1) For fuel tanks in the cabin:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g.

(2) For fuel tanks located above or behind the crew or passenger compartment that, if loosened, could injure an occupant in an emergency landing:

(i) Upward—1.5g.

(ii) Forward—8g.

(iii) Sideward—2g.

(iv) Downward—4g.

(3) For fuel tanks in other areas:

(i) Upward—1.5g.

(ii) Forward—4g.

(iii) Sideward—2g.

(iv) Downward—4g.

(c) *Fuel line self-sealing breakaway couplings.* Self-sealing breakaway couplings must be installed unless hazardous relative motion of fuel system components to each other or to local rotorcraft structure is demonstrated to be extremely improbable or unless other means are provided. The couplings or equivalent devices must be installed at all fuel tank-to-fuel line connections, tank-to-tank interconnects, and at other points in the fuel system where local structural deformation could lead to the release of fuel.

(1) The design and construction of self-sealing breakaway couplings must incorporate the following design features:

(i) The load necessary to separate a breakaway coupling must be between 25 to 50 percent of the minimum ultimate failure load (ultimate strength) of the weakest component in the fluid-carrying line. The separation load must in no case be less than 300 pounds, regardless of the size of the fluid line.

(ii) A breakaway coupling must separate whenever its ultimate load (as defined in paragraph (c)(1)(i) of this section) is applied in the failure modes most likely to occur.

or unintended closing due to operational shocks, vibrations, or accelerations.

(v) No breakaway coupling design may allow the release of fuel once the coupling has performed its intended function.

(2) All individual breakaway couplings, coupling fuel feed systems, or equivalent means must be designed, tested, installed, and maintained so that inadvertent fuel shutoff in flight is improbable in accordance with § 29.955(a) and must comply with the fatigue evaluation requirements of § 29.571 without leaking.

(3) Alternate, equivalent means to the use of breakaway couplings must not create a survivable impact-induced load on the fuel line to which it is installed greater than 25 to 50 percent of the ultimate load (strength) of the weakest component in the line and must comply with the fatigue requirements of § 29.571 without leaking.

(d) *Frangible or deformable structural attachments.* Unless hazardous relative motion of fuel tanks and fuel system components to local rotorcraft structure is demonstrated to be extremely improbable in an otherwise survivable impact, frangible or locally deformable attachments of fuel tanks and fuel system components to local rotorcraft structure must be used. The attachment of fuel tanks and fuel system components to local rotorcraft structure, whether frangible or locally deformable, must be designed such that its separation or relative local deformation will occur without rupture or local tear-out of the fuel tank or fuel system components that will cause fuel leakage. The ultimate strength of frangible or deformable attachments must be as follows:

(1) The load required to separate a frangible attachment from its support structure, or deform a locally deformable attachment relative to its support structure, must be between 25 and 50 percent of the minimum ultimate load (ultimate strength) of the weakest component in the attached system. In no case may the load be less than 300 pounds.

(2) A frangible or locally deformable attachment must separate or locally deform as intended whenever its ultimate load (as defined in paragraph (d)(1) of this section) is applied in the modes most likely to occur.

(3) All frangible or locally deformable attachments must comply with the fatigue requirements of § 29.571.

(e) *Separation of fuel and ignition sources.* To provide maximum crash resistance, fuel must be located as far as practicable from all occupiable areas and from all potential ignition sources.

(f) *Other basic mechanical design criteria.* Fuel tanks, fuel lines, electrical wires, and electrical devices must be designed, constructed, and installed, as far as practicable, to be crash resistant.

(g) *Rigid or semirigid fuel tanks.* Rigid or semirigid fuel tank or bladder walls must be impact and tear resistant.]

[(Amdt. 29–35, Eff. 11/2/94)]

§ 29.953 Fuel system independence.

(a) For category A rotorcraft—

(1) The fuel system must meet the requirements of § 29.903(b); and

(2) Unless other provisions are made to meet paragraph (a)(1) of this section, the fuel system must allow fuel to be supplied to each engine through a system independent of those parts of each system supplying fuel to other engines.

(b) Each fuel system for a multiengine category B rotorcraft must meet the requirements of paragraph (a)(2) of this section. However, separate fuel tanks need not be provided for each engine.

§ 29.954 Fuel system lightning protection.

The fuel system must be designed and arranged to prevent the ignition of fuel vapor within the system by—

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes to areas where swept strokes are highly probable; and

(c) Corona and streamering at fuel vent outlets.

(Amdt. 29–26, Eff. 10/3/88)

§ 29.955 Fuel flow.

(a) *General.* The fuel system for each engine must provide the engine with at least 100 percent of the fuel required under all operating and maneuvering conditions to be approved for the rotorcraft, including, as applicable, the fuel required to operate the engines under the test conditions required by § 29.927. Unless equivalent methods are used, compliance must be shown by test during which that established as the unusable fuel supply for that tank under § 29.959, plus that necessary to conduct the test.

(3) The fuel head between the tank and the engine must be critical with respect to rotorcraft flight attitudes.

(4) The fuel flow transmitter, if installed, and the critical fuel pump (for pump-fed systems) must be installed to produce (by actual or simulated failure) the critical restriction to fuel flow to be expected from component failure.

(5) Critical values of engine rotational speed, electrical power, or other sources of fuel pump motive power must be applied.

(6) Critical values of fuel properties which adversely affect fuel flow are applied during demonstrations of fuel flow capability.

(7) The fuel filter required by § 29.997 is blocked to the degree necessary to simulate the accumulation of fuel contamination required to activate the indicator required by § 29.1305(a)(17).

(b) *Fuel transfer system.* If normal operation of the fuel system requires fuel to be transferred to another tank, the transfer must occur automatically via a system which has been shown to maintain the fuel level in the receiving tank within acceptable limits during flight or surface operation of the rotorcraft.

(c) *Multiple fuel tanks.* If an engine can be supplied with fuel from more than one tank, the fuel system, in addition to having appropriate manual switching capability, must be designed to prevent interruption of fuel flow to the engine, without attention by the flightcrew, when any tank supplying fuel to that engine is depleted of usable fuel during normal operation and any other tank that normally supplies fuel to that engine alone contains usable fuel.

(Amdt. 29–2, Eff. 6/4/67); (Amdt. 29–26, Eff. 10/3/88)

§ 29.957 Flow between interconnected tanks.

(a) Where tank outlets are interconnected and allow fuel to flow between them due to gravity or flight accelerations, it must be impossible for fuel to flow between tanks in quantities great

(2) There must be means to warn the crew before overflow through the vents occurs.

§ 29.959 Unusable fuel supply.

The unusable fuel supply for each tank must be established as not less than the quantity at which the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight maneuvers involving that tank.

§ 29.961 Fuel system hot weather operation.

Each suction lift fuel system and other fuel systems conducive to vapor formation must be shown to operate satisfactorily (within certification limits) when using fuel at the most critical temperature for vapor formation under critical operating conditions including, if applicable, the engine operating conditions defined by § 29.927(b)(1) and (b)(2).

(d) If compliance with paragraph (b) of this section is shown in weather cold enough to interfere with the proper conduct of the test, each fuel tank surface, fuel line, and other fuel system parts subject to cold air must be insulated to simulate, insofar as practicable, flight in hot weather.

(Amdt. 29–26, Eff. 10/3/88)

§ 29.963 Fuel tanks: General.

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation.

[(b)**]** **[**Each flexible fuel tank bladder or liner must be approved or shown to be suitable for the particular application and must be puncture resistant. Puncture resistance must be shown by meeting the TSO–C80, paragraph 16.0, requirements using a minimum puncture force of 370 pounds.**]**

(**[**c**]**) Each integral fuel tank liner must have facilities for inspection and repair of its interior.

(**[**d**]**) The maximum exposed surface temperature of all components in the fuel tank must be less by a safe margin than the lowest expected autoignition temperature of the fuel or fuel vapor in the tank. Compliance with this requirement must be shown under all operating conditions and under construction of the enclosures must provide necessary protection for the tank, must be crash resistant during a survivable impact in accordance with § 29.952, and must be adequate to withstand loads and abrasions to be expected in personnel compartments.]

(Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–35, Eff. 11/2/94)]

§ 29.965 Fuel tank tests.

(a) Each fuel tank must be able to withstand the applicable pressure tests in this section without failure or leakage. If practicable, test pressures may be applied in a manner simulating the pressure distribution in service.

(b) Each conventional metal tank, each nonmetallic tank with walls that are not supported by the rotorcraft structure, and each integral tank must be subjected to a pressure of 3.5 p.s.i. unless the pressure developed during maximum limit acceleration or emergency deceleration with a full tank exceeds this value, in which case a hydrostatic head, or equivalent test, must be applied to duplicate the acceleration loads as far as possible. However, the pressure need not exceed 3.5 p.s.i. on surfaces not exposed to the acceleration loading.

(c) Each nonmetallic tank with walls supported by the rotorcraft structure must be subjected to the following tests:

(1) A pressure test of at least 2.0 p.s.i. This test may be conducted on the tank alone in conjunction with the test specified in paragraph (c)(2) of this section.

(2) A pressure test, with the tank mounted in the rotorcraft structure, equal to the load developed by the reaction of the contents, with the tank full, during maximum limit acceleration or emergency deceleration. However, the pressure need not exceed 2.0 p.s.i. on surfaces not exposed to the acceleration loading.

(d) Each tank with large unsupported or unstiffened flat areas, or with other features whose failure or deformation could cause leakage, must be subjected to the following test or its equivalent:

(1) Each complete tank assembly and its supports must be vibration tested while mounted to simulate the actual installation.

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the test frequency of vibration, in number of cycles per minute, must, unless a frequency based on a more rational analysis is used, be the number obtained by averaging the maximum and minimum power-on engine speeds (r.p.m.) for reciprocating engine powered rotorcraft or 2,000 c.p.m. for turbine engine powered rotorcraft.

(ii) If only one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under paragraph (d)(3)(ii) and (iii), the time of test must be adjusted to accomplish the same number of vibration cycles as would be accomplished in 25 hours at the frequency specified in paragraph (d)(3)(i) of this section.

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15° on both sides of the horizontal (30° total), about the most critical axis, for 25 hours). If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

(Amdt. 29–13, Eff. 5/2/77)

§ 29.967 Fuel tank installation.

(a) Each fuel tank must be supported so that tank loads are not concentrated on unsupported tank surfaces. In addition—

(1) There must be pads, if necessary, to prevent chafing between each tank and its supports;

(2) The padding must be nonabsorbent or treated to prevent the absorption of fuel;

(3) If flexible tank liners are used, they must be supported so that they are not required to withstand fluid loads; and

(b) Any spaces adjacent to tank surfaces must be adequately ventilated to avoid accumulation of fuel or fumes in those spaces due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes that prevent clogging and that prevent excessive pressure resulting from altitude changes. If flexible tank liners are installed, the venting arrangement for the spaces between the liner and its container must maintain the proper relationship to tank vent pressures for any expected flight condition.

(c) The location of each tank must meet the requirements of § 29.1185(b) and (c).

(d) No rotorcraft skin immediately adjacent to a major air outlet from the engine compartment may act as the wall of an integral tank.

(e) [Removed]

(Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–35, Eff. 11/2/94)]

§ 29.969 Fuel tank expansion space.

Each fuel tank or each group of fuel tanks with interconnected vent systems must have an expansion space of not less than 2 percent of the combined tank capacity. It must be impossible to fill the fuel tank expansion space inadvertently with the rotorcraft in the normal ground attitude.

(Amdt. 29–26, Eff. 10/3/88)

§ 29.971 Fuel tank sump.

(a) Each fuel tank must have a sump with a capacity of not less than the greater of—

(1) 0.10 percent of the tank capacity of—

(2) One-sixteenth gallon.

(b) The capacity prescribed in paragraph (a) of this section must be effective with the rotorcraft in any normal attitude, and must be located so that the sump contents cannot escape through the tank outlet opening.

(c) Each fuel tank must allow drainage of hazardous quantities of water from each part of the tank to the sump with the rotorcraft in any ground attitude to be expected in service.

§ 29.973 Fuel tank filler connection.

(a) [Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank itself during normal operations and must be crash resistant during a survivable impact in accordance with § 29.952(c). In addition—

(1) Each filler must be marked as prescribed in § 29.1557(c)(1);

(2) Each recessed filler connection that can retain any appreciable quantity of fuel must have a drain that discharges clear of the entire rotorcraft; and

(3) Each filler cap must provide a fuel-tight seal under the fluid pressure expected in normal operation and in a survivable impact.

(b) Each filler cap or filler cap cover must warn when the cap is not fully locked or seated on the filler connection.]

[(Amdt. 29–35, Eff. 11/2/94)]

§ 29.975 Fuel tank vents and carburetor vapor vents.

(a) *Fuel tank vents.* Each fuel tank must be vented from the top part of the expansion space so that venting is effective under normal flight conditions. In addition—

(1) The vents must be arranged to avoid stoppage by dirt or ice formation;

(2) The vent arrangement must prevent siphoning of fuel during normal operation;

(3) The venting capacity and vent pressure levels must maintain acceptable differences of pressure between the interior and exterior of the tank during—

(i) Normal flight operation;

(ii) Maximum rate of ascent and descent; and

(iii) Refueling and defueling (where applicable);

(4) Airspaces of tanks with interconnected outlets must be interconnected;

(5) There may be no point in any vent line where moisture can accumulate with the rotorcraft in the ground attitude or the level flight attitude, unless drainage is provided;

minimize spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operations, or a survivable impact, unless a rollover is shown to be extremely remote.]

(b) *Carburetor vapor vents.* Each carburetor with vapor elimination connections must have a vent line to lead vapors back to one of the fuel tanks. In addition—

(1) Each vent system must have means to avoid stoppage by ice; and

(2) If there is more than one fuel tank, and it is necessary to use the tanks in a definite sequence, each vapor vent return line must lead back to the fuel tank used for takeoff and landing.

(Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–35, Eff. 11/2/94)]

§ 29.977 Fuel tank outlet.

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must—

(1) For reciprocating engine powered airplanes, have 8 to 16 meshes per inch; and

(2) For turbine engine powered airplanes, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each finger strainer must be accessible for inspection and cleaning.

(Amdt. 29–12, Eff. 2/1/77)

§ 29.979 Pressure refueling and fueling provisions below fuel level.

(a) Each fueling connection below the fuel level in each tank must have means to prevent the escape of hazardous quantities of fuel from that tank in case of malfunction of the fuel entry valve.

(b) For systems intended for pressure refueling, a means in addition to the normal means for limiting the tank content must be installed to prevent

pressure must be established with any combination of tank valves being either intentionally or inadvertently closed.

(d) The rotorcraft defueling system (not including fuel tanks and fuel tank vents) must withstand an ultimate load that is 2.0 times the load arising from the maximum permissible defueling pressure (positive or negative) at the rotorcraft fueling connection.

(Amdt. 29–12, Eff. 2/1/77)

FUEL SYSTEM COMPONENTS

§ 29.991 Fuel pumps.

(a) Compliance with § 29.955 must not be jeopardized by failure of—

(1) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or

(2) Any component required for pump operation except the engine served by that pump.

(b) The following fuel pump installation requirements apply:

(1) When necessary to maintain the proper fuel pressure—

(i) A connection must be provided to transmit the carburetor air intake static pressure to the proper fuel pump relief valve connection; and

(ii) The gauge balance lines must be independently connected to the carburetor inlet pressure to avoid incorrect fuel pressure readings.

(2) The installation of fuel pumps having seals or diaphragms that may leak must have means for draining leaking fuel.

(3) Each drain line must discharge where it will not create a fire hazard.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–26, Eff. 10/3/88)

§ 29.993 Fuel system lines and fittings.

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure, valve actuation, and accelerated flight conditions.

(e) No flexible hose that might be adversely affected by high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

§ 29.995 Fuel valves.

In addition to meeting the requirements of § 29.1189, each fuel valve must—

(a) [Reserved]

(b) Be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

(Amdt. 29–13, Eff. 5/2/77)

§ 29.997 Fuel strainer or filter.

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of the first fuel system component which is susceptible to fuel contamination, including but not limited to the fuel metering device or an engine positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must—

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain, except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Provide a means to remove from the fuel any contaminant which would jeopardize the flow of fuel through rotorcraft or engine fuel system components required for proper rotorcraft or engine fuel system components required for proper rotorcraft or engine fuel system operation.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–10, Eff. 10/31/74); (Amdt. 29–22, Eff. 3/26/84); (Amdt. 29–26, Eff. 10/3/88)

must—

(1) Discharge clear of all parts of the rotorcraft;

(2) Have manual or automatic means to ensure positive closure in the off position; and

(3) Have a drain valve—

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the vent of a landing with landing gear retracted.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1001 Fuel jettisoning.

If a fuel jettisoning system is installed, the following apply:

(a) Fuel jettisoning must be safe during all flight regimes for which jettisoning is to be authorized.

(b) In showing compliance with paragraph (a) of this section, it must be shown that—

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) No hazard results from fuel or fuel vapors which impinge on any part of the rotorcraft during fuel jettisoning; and

(3) Controllability of the rotorcraft remains satisfactory throughout the fuel jettisoning operation.

(c) Means must be provided to automatically prevent jettisoning fuel below the level required for an all-engine climb at maximum continuous power from sea level to 5,000 feet altitude and cruise thereafter for 30 minutes at maximum range engine power.

(d) The controls for any fuel jettisoning system must be designed to allow flight personnel (minimum crew) to safely interrupt fuel jettisoning during any part of the jettisoning operation.

(e) The fuel jettisoning system must be designed to comply with the powerplant installation requirements of § 29.901(c).

(f) An auxiliary fuel jettisoning system which meets the requirements of paragraphs (a), (b), (d), and (e) of this section may be installed to jettison

§ 29.1011 Engines: General.

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity of each system may not be less than the product of the endurance of the rotorcraft under critical operating conditions and the maximum allowable oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling. Instead of a rational analysis of endurance and consumption, a usable oil capacity of one gallon for each 40 gallons of usable fuel may be used for reciprocating engine installations.

(c) Oil-fuel ratios lower than those prescribed in paragraph (c) of this section may be used if they are substantiated by data on the oil consumption of the engine.

(d) The ability of the engine oil cooling provisions to maintain the oil temperature at or below the maximum established value must be shown under the applicable requirements of §§ 29.1041 through 29.1049.

(Amdt. 29–26, Eff. 10/3/88)

§ 29.1013 Oil tanks.

(a) *Installation.* Each oil tank installation must meet the requirements of § 29.967.

(b) *Expansion space.* Oil tank expansion space must be provided so that—

(1) Each oil tank used with a reciprocating engine has an expansion space of not less than the greater of 10 percent of the tank capacity of 0.5 gallon, and each oil tank used with a turbine engine has an expansion space of not less than 10 percent of the tank capacity;

(2) Each reserve oil tank not directly connected to any engine has an expansion space of not less than 2 percent of the tank capacity; and

(3) It is impossible to fill the expansion space inadvertently with the rotorcraft in the normal ground attitude.

(c) *Filler connection.* Each recessed oil tank filler connection that can retain any appreciable quantity features that provide a warning when caps are not fully locked or seated on the filler connection; and

(3) Each oil filler must be marked under § 29.1557(c)(2).

(d) *Vent.* Oil tanks must be vented as follows:

(1) Each oil tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions.

(2) Oil tank vents must be arranged so that condensed water vapor that might freeze and obstruct the line cannot accumulate at any point.

(e) *Outlet.* There must be means to prevent entrance into the tank itself, or into the tank outlet, of any object that might obstruct the flow of oil through the system. No oil tank outlet may be enclosed by a screen or guard that would reduce the flow of oil below a safe value at any operating temperature. There must be a shutoff valve at the outlet of each oil tank used with a turbine engine unless the external portion of the oil system (including oil tank supports) is fireproof.

(f) *Flexible liners.* Each flexible oil tank liner must be approved or shown to be suitable for the particular installation.

(Amdt. 29–10, Eff. 10/31/74)

§ 29.1015 Oil tank tests.

Each oil tank must be designed and installed so that—

(a) It can withstand, without failure, any vibration, inertia, and fluid loads to which it may be subjected in operation; and

(b) It meets the requirements of § 29.965, except that instead of the pressure specified in § 29.965(b)—

(1) For pressurized tanks used with a turbine engine, the test pressure may not be less than 5 p.s.i. plus the maximum operating pressure of the tank; and

(2) For all other tanks, the test pressure may not be less than 5 p.s.i.

(Amdt. 29–10, Eff. 10/31/74)

point;

(2) The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield; and

(3) The breather does not discharge into the engine air induction system.

§ 29.1019 Oil strainer or filter.

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitation established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under part 33 of this chapter.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with paragraph (a)(2) of this section.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in § 29.1305(a)(18).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

(Amdt. 29–10, Eff. 10/31/74); (Amdt. 29–22, Eff. 3/26/84); (Amdt. 29–26, Eff. 10/3/88)

(Amdt. 29–22, Eff. 3/26/84)

§ 29.1023 Oil radiators.

(a) Each oil radiator must be able to withstand any vibration, inertia, and oil pressure loads to which it would be subjected in operation.

(b) Each oil radiator air duct must be located, or equipped, so that, in case of fire, and with the airflow as it would be with and without the engine operating, flames cannot directly strike the radiator.

§ 29.1025 Oil valves.

(a) Each oil shutoff must meet the requirements of § 29.1189.

(b) The closing of oil shutoffs may not prevent autorotation.

(c) Each oil valve must have positive stops or suitable index provisions in the "on" and "off" positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

§ 29.1027 Transmission and gearboxes: General.

(a) The oil system for components of the rotor drive system that require continuous lubrication must be sufficiently independent of the lubrication systems of the engine(s) to ensure—

(1) Operation with any engine inoperative; and

(2) Safe autorotation.

(b) Pressure lubrication systems for transmissions and gearboxes must comply with the requirements of §§ 29.1013, paragraphs (c), (d), and (f) only, 29.1015, 29.1017, 29.1021, 29.1023, and 29.1337(d). In addition, the system must have—

(1) An oil strainer or filter through which all the lubricant flows, and must—

(i) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree; and

(ii) Be equipped with a bypass constructed and installed so that—

(iii) Be equipped with a means to indicate collection of contaminants on the filter or strainer at or before opening of the bypass;

(2) For each lubricant tank or sump outlet supplying lubrication to rotor drive systems and rotor drive system components, a screen to prevent entrance into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by paragraph (b)(1) of this section. The requirements of paragraph (b)(1) of this section do not apply to screens installed at lubricant tank or sump outlets.

(c) Splash type lubrication systems for rotor drive system gearboxes must comply with §§ 29.1021 and 29.1337(d).

(Amdt. 29–26, Eff. 10/3/88)

COOLING

§ 29.1041 General.

(a) The powerplant and auxiliary power unit cooling provisions must be able to maintain the temperatures of power plant components, engine fluids, and auxiliary power unit components and fluids within the temperature limits established for these components and fluids, under ground, water, and flight operating conditions for which certification is requested, and after normal engine or auxiliary power shutdown, or both.

(b) There must be cooling provisions to maintain the fluid temperatures in any power transmission within safe values under any critical surface (ground or water) and flight operating conditions.

(c) Except for ground-use-only auxiliary power units, compliance with paragraphs (a) and (b) of this section must be shown by flight tests in which the temperatures of selected powerplant component and auxiliary power unit component, engine, and transmission fluids are obtained under the conditions prescribed in those paragraphs.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–26, Eff. 10/3/88)

(b) of this section, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section, unless a more rational correction method is applicable.

(2) No corrected temperature determined under paragraph (a)(1) of this section may exceed established limits.

(3) The fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those used in normal operation.

(4) The test procedures must be as prescribed in §§ 29.1045 through 29.1049.

(5) For the purposes of the cooling tests, a temperature is "stabilized" when its rate of change is less than 2°F per minute.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F. must be established. The assumed temperature lapse rate is 3.6 degrees F. per thousand feet of altitude above sea level until a temperature of −69.7 degrees F. is reached, above which altitude the temperature is considered constant at −69.7 degrees F. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.

(c) *Correction factor (except cylinder barrels).* Unless a more rational correction applies, temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum

(a) Climb cooling tests must be conducted under this section for—

(1) Category A rotorcraft; and

(2) Multiengine category B rotorcraft for which certification is requested under the category A powerplant installation requirements, and under the requirements of § 29.861(a) at the steady rate of climb or descent established under § 29.67(b).

(b) The climb or descent cooling tests must be conducted with the engine inoperative that produces the most adverse cooling conditions for the remaining engines and powerplant components.

(c) Each operating engine must—

(1) For helicopters for which the use of 30-minute OEI power is requested, be at 30-minute OEI power for 30 minutes, and then at maximum continuous power (or at full throttle when above the critical altitude);

(2) For helicopters for which the use of continuous OEI power is requested, be at continuous OEI power (or at full throttle when above the critical altitude); and

(3) For other rotorcraft, be at maximum continuous power (or at full throttle when above the critical altitude).

(d) After temperatures have stabilized in flight, the climb must be—

(1) Begun from an altitude not greater than the lower of—

(i) 1,000 feet below the engine critical altitude; and

(ii) 1,000 feet below the maximum altitude at which the rate of climb is 150 f.p.m.; and

(2) Continued for at least 5 minutes after the occurrence of the highest temperature recorded, or until the rotorcraft reaches the maximum altitude for which certification is requested.

(e) For category B rotorcraft without a positive rate of climb, the descent must begin at the all-engine-critical altitude and end at the higher of—

(1) The maximum altitude at which level flight can be maintained with one engine operative; and

(2) Sea level.

(f) The climb or descent must be conducted at an airspeed representing a normal operational practice for the configuration being tested. However,

3/88)

§ 29.1047 Takeoff cooling test procedures.

(a) *Category A.* For each category A rotorcraft, cooling must be shown during takeoff and subsequent climb as follows:

(1) Each temperature must be stabilized while hovering in ground effect with—

(i) The power necessary for hovering;

(ii) The appropriate cowl flap and shutter settings; and

(iii) The maximum weight.

(2) After the temperatures have stabilized, a climb must be started at the lowest practicable altitude and must be conducted with one engine inoperative.

(3) The operating engines must be at the greatest power for which approval is sought (or at full throttle when above the critical altitude) for the same period as this power is used in determining the takeoff climbout path under § 29.59.

(4) At the end of the time interval prescribed in paragraph (b)(3) of this section, the power must be changed to that used in meeting § 29.67(a)(2) and the climb must be continued for—

(i) Thirty minutes, if 30-minute OEI power is used; or

(ii) At least 5 minutes after the occurrence of the highest temperature recorded, if continuous OEI power or maximum continuous power is used.

(5) The speeds must be those used in determining the takeoff flight path under § 29.59.

(b) *Category B.* For each category B rotorcraft, cooling must be shown during takeoff and subsequent climb as follows:

(1) Each temperature must be stabilized while hovering in ground effect with—

(i) The power necessary for hovering;

(ii) The appropriate cowl flap and shutter settings; and

(iii) The maximum weight.

(2) After the temperatures have stabilized, a climb must be started at the lowest practicable altitude with takeoff power.

five minutes after the occurrence of the highest temperature recorded.

(5) The cooling test must be conducted at an airspeed corresponding to normal operating practice for the configuration being tested. However, if the cooling provisions are sensitive to rotorcraft speed, the most critical airspeed must be used, but need not exceed the speed for best rate of climb with maximum continuous power.

(Amdt. 29–1, Eff. 8/12/65); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1049 Hovering cooling test procedures.

The hovering cooling provisions must be shown—

(a) At maximum weight or at the greatest weight at which the rotorcraft can hover (if less), at sea level, with the power required to hover but not more than maximum continuous power, in the ground effect in still air, until at least five minutes after the occurrence of the highest temperature recorded; and

(b) With maximum continuous power, maximum weight, and at the altitude resulting in zero rate of climb for this configuration, until at least five minutes after the occurrence of the highest temperature recorded.

INDUCTION SYSTEM

§ 29.1091 Air induction.

(a) The air induction system for each engine and auxiliary power unit must supply the air required by that engine and auxiliary power unit under the operating conditions for which certification is requested.

(b) Each engine and auxiliary power unit air induction system must provide air for proper fuel metering and mixture distribution with the induction system valves in any position.

(c) No air intake may open within the engine accessory section or within other areas of any powerplant compartment where emergence of backfire flame would constitute a fire hazard.

(d) Each reciprocating engine must have an alternate air source.

drains, vents, or other components of flammable fluid systems from entering the engine or auxiliary power unit intake system; and

(2) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–17, Eff. 12/1/78)

§ 29.1093 Induction system icing protection.

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 30° F., and with the engines at 60 percent of maximum continuous power—

(1) Each rotorcraft with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90° F.;

(2) Each rotorcraft with sea level engines using carburetors tending to prevent icing has a preheater that can provide a heat rise of 70° F.;

(3) Each rotorcraft with altitude engines using conventional venturi carburetors has a preheater that can provide a heat rise of 120° F.; and

(4) Each rotorcraft with altitude engines using carburetors tending to prevent icing has a preheater that can provide a heat rise of 100° F.

(b) *Turbine engines.* (1) It must be shown that each turbine engine and its air inlet system can operate throughout the flight power range of the engine (including idling)—

(i) Without accumulating ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power under the icing conditions specified in appendix C of this part; and

(ii) In snow, both falling and blowing, without adverse effect on engine operation, within the limitations established for the rotorcraft.

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°

erate power or thrust setting in a manner acceptable to the Administrator.

(c) *Supercharged reciprocating engines.* For each engine having a supercharger to pressurize the air before it enters the carburetor, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with paragraph (a) of this section if the heat rise utilized is that which will be available, automatically, for the applicable altitude and operation condition because of supercharging.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–10, Eff. 10/31/74); (Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–22, Eff. 3/26/84); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1101 Carburetor air preheater design.

Each carburetor air preheater must be designed and constructed to—

(a) Ensure ventilation of the preheater when the engine is operated in cold air;

(b) Allow inspection of the exhaust manifold parts that it surrounds; and

(c) Allow inspection of critical parts of the preheater itself.

§ 29.1103 Induction systems ducts and air duct systems.

(a) Each induction system duct upstream of the first stage of the engine supercharger and of the auxiliary power unit compressor must have a drain to prevent the hazardous accumulation of fuel and moisture in the ground attitude. No drain may discharge where it might cause a fire hazard.

(b) Each duct must be strong enough to prevent induction system failure from normal backfire conditions.

(c) Each duct connected to components between which relative motion could exist must have means for flexibility.

(d) Each duct within any fire zone for which a fire-extinguishing system is required must be at least—

(1) Fireproof, if it passes through any firewall; or

through auxiliary power unit ducts and entering any other compartment or area of the rotorcraft in which a hazard would be created resulting from the entry of hot gases. The materials used to form the remainder of the induction system duct and plenum chamber of the auxiliary power unit must be capable of resisting the maximum heat conditions likely to occur.

(f) Each auxiliary power unit induction system duct must be constructed of materials that will not absorb or trap hazardous quantities of flammable fluids that could be ignited in the event of a surge or reverse flow condition.

(Amdt. 29–17, Eff. 12/1/78)

§ 29.1105 Induction system screens.

If induction system screens are used—

(a) Each screen must be upstream of the carburetor;

(b) No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless it can be deiced by heated air;

(c) No screen may be deiced by alcohol alone; and

(d) It must be impossible for fuel to strike any screen.

§ 29.1107 Inter-coolers and after-coolers.

Each inter-cooler and after-cooler must be able to withstand the vibration, inertia, and air pressure loads to which it would be subjected in operation.

§ 29.1109 Carburetor air cooling.

It must be shown under § 29.1043 that each installation using two-stage superchargers has means to maintain the air temperature, at the carburetor inlet, at or below the maximum established value.

EXHAUST SYSTEM

§ 29.1121 General.

For powerplant and auxiliary power unit installations the following apply:

system carrying flammable fluids or vapors will not result in a fire caused by impingement of the fluids or vapors on any part of the exhaust system including shields for the exhaust system.

(c) Each component upon which hot exhaust gases could impinge, or that could be subjected to high temperatures from exhaust system parts, must be fireproof. Each exhaust system component must be separated by a fireproof shield from adjacent parts of the rotorcraft that are outside the engine and auxiliary power unit compartments.

(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.

(e) No exhaust gases may discharge where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable fluids or vapors outside the shroud.

(h) If significant traps exist, each turbine engine exhaust system must have drains discharging clear of the rotorcraft, in any normal ground and flight attitudes, to prevent fuel accumulation after the failure of an attempted engine start.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–13, Eff. 5/2/77)

§ 29.1123 Exhaust piping.

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation.

(c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

§ 29.1125 Exhaust heat exchangers.

For reciprocating engine powered rotorcraft the following apply:

(2) There must be means for inspecting the critical parts of each exchanger;

(3) Each exchanger must have cooling provisions wherever it is subject to contact with exhaust gases; and

(4) [No] exhaust heat exchanger [or] muff may have stagnant areas or liquid traps that would increase the probability of ignition of flammable fluids or vapors that might be present in case of the failure or malfunction of components carrying flammable fluids.

(b) If an exhaust heat exchanger is used for heating ventilating air used by personnel—

(1) There must be a secondary heat exchanger between the primary exhaust gas heat exchanger and the ventilating air system; or

(2) Other means must be used to prevent harmful contamination of the ventilating air.

(Amdt. 29–12, Eff. 2/1/77); [(Amdt. 29–41, Eff. 11/28/97)]

POWERPLANT CONTROLS AND ACCESSORIES

§ 29.1141 Powerplant controls: General.

(a) Powerplant controls must be located and arranged under § 29.777 and marked under § 29.1555.

(b) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in the cockpit.

(c) Each flexible powerplant control must be approved.

(d) Each control must be able to maintain any set position without—

(1) Constant attention; or

(2) Tendency to creep due to control loads or vibration.

(e) Each control must be able to withstand operating loads without excessive deflection.

(f) Controls of powerplant valves required for safety must have—

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position; and

(Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1142 Auxiliary power unit controls.

Means must be provided on the flight deck for starting, stopping, and emergency shutdown of each installed auxiliary power unit.

(Amdt. 29–17, Eff. 12/1/78)

§ 29.1143 Engine controls.

(a) There must be a separate power control for each engine.

(b) Power controls must be arranged to allow ready synchronization of all engines by—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power control must provide a positive and immediately responsive means of controlling its engine.

(d) Each fluid injection control other than fuel system control must be in the corresponding power control. However, the injection system pump may have a separate control.

(e) if a power control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must—

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

[(f) For rotorcraft to be certificated for a 30-second OEI power rating, a means must be provided to automatically activate and control the 30-second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30-second OEI power rating approved for the rotorcraft.]

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–34, Eff. 10/17/94)]

§ 29.1145 Ignition switches.

(a) Ignition switches must control each ignition circuit on each engine.

operation.

(Amdt. 29–13, Eff. 5/2/77)

§ 29.1147 Mixture controls.

(a) If there are mixture controls, each engine must have a separate control, and the controls must be arranged to allow—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(b) Each intermediate position of the mixture controls that corresponds to a normal operating setting must be identifiable by feel and sight.

§ 29.1151 Rotor brake controls.

(a) It must be impossible to apply the rotor brake inadvertently in flight.

(b) There must be means to warn the crew if the rotor brake has not been completely released before takeoff.

§ 29.1157 Carburetor air temperature controls.

There must be a separate carburetor air temperature control for each engine.

§ 29.1159 Supercharger controls.

Each supercharger control must be accessible to—

(a) The pilots; or

(b) (If there is a separate flight engineer station with a control panel) the flight engineer.

§ 29.1163 Powerplant accessories.

(a) Each engine mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimize the probability of igniting flammable fluids or vapors.

limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–22, Eff. 3/26/84); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1165 Engine ignition systems.

(a) Each battery ignition system must be supplemented with a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw from the same source.

(c) The design of the engine ignition system must account for—

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) Magneto ground wiring (for separate ignition circuits) that lies on the engine side of any firewall must be installed, located, or protected to minimize the probability of the simultaneous failure of two or more wires as a result of mechanical damage, electrical fault, or other cause.

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit that is not used for assisting, controlling, or analyzing the operation of that system.

(g) There must be means to warn appropriate crewmembers if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(Amdt. 29–12, Eff. 2/1/77)

(1) The engine power section of reciprocating engines;

(2) The engine accessory section of reciprocating engines;

(3) Any complete powerplant compartment in which there is no isolation between the engine power section and the engine accessory section, for reciprocating engines;

(4) Any auxiliary power unit compartment;

(5) Any fuel-burning heater and other combustion equipment installation described in § 29.859;

(6) The compressor and accessory sections of turbine engines; and

(7) The combustor, turbine, and tailpipe sections of turbine engine installations except sections that do not contain lines and components carrying flammable fluids or gases and are isolated from the designated fire zone prescribed in paragraph (a)(6) of this section by a firewall that meets § 29.1191.

(b) Each designated fire zone must meet the requirements of §§ 29.1183 through 29.1203.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–26, Eff. 10/3/88)

§ 29.1183 Lines, fittings, and components.

(a) Except as provided in paragraph (b) of this section, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 25-quart capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Paragraph (a) of this section does not apply to—

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

§ 29.1185 Flammable fluids.

(a) No tank or reservoir that is part of a system containing flammable fluids or gases may be in a designated fire zone unless the fluid contained, the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines, and controls provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.

(b) Each fuel tank must be isolated from the engines by a firewall or shroud.

(c) There must be at least one-half inch of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone, unless equivalent means are used to prevent heat transfer from the fire zone to the flammable fluid.

(d) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

§ 29.1187 Drainage and ventilation of fire zones.

(a) There must be complete drainage of each part of each designated fire zone to minimize the hazards resulting from failure or malfunction of any component containing flammable fluids. The drainage means must be—

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharged fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapors.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapors, or flame from other zones.

(d) Ventilation means must be arranged so that no discharged vapors will cause an additional fire hazard.

(e) For category A rotorcraft, there must be means to allow the crew to shut off the sources of forced ventilation in any fire zone (other than the engine power section of the powerplant compartment) unless the amount of extinguishing agent and the rate of discharge are based on the maximum airflow through that zone.

(1) For lines, fittings, and components forming an integral part of an engine;

(2) For oil systems for turbine engine installations in which all components of the oil system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; or

(3) For engine oil systems in category B rotorcraft using reciprocating engines of less than 500 cubic inches displacement.

(b) The closing of any fuel shutoff valve for any engine may not make fuel unavailable to the remaining engines.

(c) For category A rotorcraft, no hazardous quantity of flammable fluid may drain into any designated fire zone after shutoff has been accomplished, nor may the closing of any fuel shutoff valve for an engine make fuel unavailable to the remaining engines.

(d) The operation of any shutoff may not interfere with the later emergency operation of any other equipment, such as the means for declutching the engine from the rotor drive.

(e) Each shutoff valve and its control must be designed, located, and protected to function properly under any condition likely to result from fire in a designated fire zone.

(f) Except for ground-use-only auxiliary power unit installations, there must be means to prevent inadvertent operation of each shutoff and to make it possible to reopen it in flight after it has been closed.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–22, Eff. 3/26/84)

§ 29.1191 Firewalls.

(a) Each engine, including the combustor, turbine, and tailpipe sections of turbine engine installations, must be isolated by a firewall, shroud, or equivalent means, from personnel compartments, structures, controls, rotor mechanisms, and other parts that are—

(1) Essential to controlled flight and landing; and

(2) Not protected under § 29.861.

(b) Each auxiliary power unit, combustion heater, and other combustion equipment to be used in be sealed with close-fitting fireproof grommets, bushings, or firewall fittings.

(e) Each firewall and shroud must be fireproof and protected against corrosion.

(f) In meeting this section, account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.1193 Cowling and engine compartment covering.

(a) Each cowling and engine compartment covering must be constructed and supported so that it can resist the vibration, inertia, and air loads to which it may be subjected in operation.

(b) Cowling must meet the drainage and ventilation requirements of § 29.1187.

(c) On rotorcraft with a diaphragm isolating the engine power section from the engine accessory section, each part of the accessory section cowling subject to flame in case of fire in the engine power section of the powerplant must—

(1) Be fireproof; and

(2) Meet the requirements of § 29.1191.

(d) Each part of the cowling or engine compartment covering subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(e) Each rotorcraft must—

(1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards;

(2) Meet the requirements of paragraph (e)(1) of this section with the landing gear retracted (if applicable); and

(3) Have fireproof skin in areas subject to flame if a fire starts in or burns out of any designated fire zone.

(f) A means of retention for each openable or readily removable panel, cowling, or engine or rotor drive system covering must be provided to preclude hazardous damage to rotors or critical control components in the event of—

§ 29.1194 Other surfaces.

All surfaces aft of, and near, engine compartments and designated fire zones, other than tail surfaces not subject to heat flames, or sparks emanating from a designated fire zone or engine compartment, must be at least fire resistant.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.1195 Fire extinguishing systems.

(a) Each turbine engine powered rotorcraft and Category A reciprocating engine powered rotorcraft, and each Category B reciprocating engine powered rotorcraft with engines of more than 1,500 cubic inches must have a fire extinguishing system for the designated fire zones. The fire extinguishing system for a powerplant must be able to simultaneously protect all zones of the powerplant compartment for which protection is provided.

(b) For multiengine powered rotorcraft, the fire extinguishing system, the quantity of extinguishing agent, and the rate of discharge must—

(1) For each auxiliary power unit and combustion equipment, provide at least one adequate discharge; and

(2) For each other designated fire zone, provide two adequate discharges.

(c) For single engine rotorcraft, the quantity of extinguishing agent and the rate of discharge must provide at least one adequate discharge for the engine compartment.

(d) It must be shown by either actual or simulated flight tests that under critical airflow conditions in flight the discharge of the extinguishing agent in each designated fire zone will provide an agent concentration capable of extinguishing fires in that zone and of minimizing the probability of reignition.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–17, Eff. 12/1/78)

§ 29.1197 Fire extinguishing agents.

(a) Fire extinguishing agents must—

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combus-

must be shown by test that entry of harmful concentrations of fluid or fluid vapors into any personnel compartment (due to leakage during normal operation of the rotorcraft, or discharge on the ground or in flight) is prevented, even though a defect may exist in the extinguishing system.

(c) [Deleted]

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–13, Eff. 5/2/77)

§ 29.1199 Extinguishing agent containers.

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishing agent would not damage the rotorcraft. The line must also be located or protected to prevent clogging caused by ice or other foreign matter.

(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from—

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(Amdt. 29–13, Eff. 5/2/77)

§ 29.1203 Fire detector systems.

(a) For each turbine engine powered rotorcraft and category A reciprocating engine powered rotorcraft, and for each category B reciprocating engine powered rotorcraft with engines of more than 900 cubic inches displacement, there must be approved, quick-acting fire detectors in designated fire zones and in the combustor, turbine, and tailpipe sections of turbine installations (whether or not such sections are designated fire zones) in numbers and locations ensuring prompt detection of fire in those zones.

(b) Each fire detector must be constructed and installed to withstand any vibration, inertia, and other loads to which it would be subjected in operation.

(c) No fire detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow crewmembers to check, in flight, the functioning of each fire detector system electrical circuit.

(e) The wiring and other components of each fire detector system in an engine compartment must be at least fire resistant.

(f) No fire detector system component for any fire zone may pass through another fire zone, unless—

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) The zones involved are simultaneously protected by the same detector and extinguishing systems.

(Amdt. 29–3, Eff. 2/25/68)

§ 29.1501 General.

(a) Each operating limitation specified in §§ 29.1503 through 29.1525 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crewmembers as prescribed in §§ 29.1541 through 29.1589.

(Amdt. 29–15, Eff. 3/1/78)

OPERATING LIMITATIONS

§ 29.1503 Airspeed limitations: General.

(a) An operating speed range must be established.

(b) When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, airspeed limitations corresponding with the critical combinations of these factors must be established.

§ 29.1505 Never-exceed speed.

(a) The never-exceed speed, V_{NE}, must be established so that it is—

(1) Not less than 40 knots (CAS); and

(2) Not more than the lesser of—

(i) 0.9 times the maximum forward speeds established under § 29.309;

(ii) 0.9 times the maximum speed shown under §§ 29.251 and 29.629; or

(iii) 0.9 times the maximum speed substantiated for advancing blade tip mach number effects under critical altitude conditions.

(b) V_{NE} may vary with altitude, r.p.m., temperature, and weight, if—

(1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time; and

(2) The ranges of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow an operationally practical and safe variation of V_{NE}.

(c) For helicopters, a stabilized power-off V_{NE} denoted as V_{NE} (power-off) may be established at a speed less than V_{NE} established pursuant to paragraph (a) of this section, if the following conditions are met:

(1) V_{NE} (power-off) is not less than a speed midway between the power-on V_{NE} and the speed used in meeting the requirements of—

(i) § 29.67(a)(3) for Category A helicopters;

(ii) § 29.65(a) for Category B helicopters, except multi-engine helicopters meeting the requirements of § 29.67(b); and

(iii) § 29.67(b) for multi-engine Category B helicopters meeting the requirements of § 29.67(b).

(2) V_{NE} (power-off) is—

(i) A constant airspeed;

(ii) A constant amount less than power-on V_{NE}; or

(iii) A constant airspeed for a portion of the altitude range for which certification is requested, and a constant amount less than power-on V_{NE} for the remainder of the altitude range.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–15, Eff. 3/1/78); (Amdt. 29–24, Eff. 12/6/84)

§ 29.1509 Rotor speed.

(a) *Maximum power-off (autorotation).* The maximum power-off rotor speed must be established so that it does not exceed 95 percent of the lesser of—

(1) The maximum design r.p.m. determined under § 29.309(b); and

(2) The maximum r.p.m. shown during the type tests.

(b) *Minimum power-off.* The minimum power-off rotor speed must be established so that it is not less than 105 percent of the greater of—

(1) The minimum shown during the type tests; and

(2) The minimum determined by design substantiation.

(c) *Minimum power-on.* The minimum power-on rotor speed must be established so that it is—

§ 29.1517 Limiting height-speed envelope.

For Category A rotorcraft, if a range of heights exists at any speed, including zero, within which it is not possible to make a safe landing following power failure, the range of heights and its variation with forward speed must be established, together with any other pertinent information, such as the kind of landing surface.

(Amdt. 29–21, Eff. 3/2/83)

§ 29.1519 Weight and center of gravity.

The weight and center of gravity limitations determined under §§ 29.25 and 29.27, respectively, must be established as operating limitations.

§ 29.1521 Powerplant limitations.

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines are type certificated.

(b) *Takeoff operation.* The powerplant takeoff operation must be limited by—

(1) The maximum rotational speed which may not be greater than—

(i) [The maximum value determined by the rotor design; or]

(ii) The maximum value shown during the type tests;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable turbine inlet or turbine outlet gas temperature (for turbine engines);

(4) The maximum allowable power or torque for each engine, considering the power input limitations of the transmission with all engines operating;

(5) The maximum allowable power or torque for each engine considering the power input limitations of the transmission with one engine inoperative;

(6) The time limit for the use of the power corresponding to the limitations established in paragraphs (b)(1) through (5) of this section; and

(c) *Continuous operation.* The continuous operation must be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The minimum rotational speed shown under the rotor speed requirements in § 29.1509(c).

(3) The maximum allowable manifold pressure (for reciprocating engines);

(4) The maximum allowable turbine inlet or turbine outlet gas temperature (for turbine engines);

(5) The maximum allowable power or torque for each engine, considering the power input limitations of the transmission with all engines operating;

(6) The maximum allowable power or torque for each engine, considering the power input limitations of the transmission with one engine inoperative; and

(7) The maximum allowable temperatures for—

(i) The cylinder head or coolant outlet (for reciprocating engines);

(ii) The engine oil; and

(iii) The transmission oil.

(d) *Fuel grade or designation.* The minimum fuel grade (for reciprocating engines) or fuel designation (for turbine engines) must be established so that it is not less than that required for the operation of the engines within the limitations in paragraphs (b) and (c) of this section.

(e) *Ambient temperature.* Ambient temperature limitations (including limitations for winterization installations if applicable) must be established as the maximum ambient atmospheric temperature at which compliance with the cooling provisions of §§ 29.1041 through 29.1049 is shown.

(f) *Two and one-half-minute OEI power operation.* Unless otherwise authorized, the use of 2½-minute OEI power must be limited to engine failure operation of multiengine, turbine-powered rotorcraft for not longer than 2½ minutes for any period type tests;

(2) The maximum allowable gas temperature;

(3) The maximum allowable torque; and

(4) The maximum allowable oil temperature.

(g) *Thirty-minute OEI power operation.* Unless otherwise authorized, the use of 30-minute OEI power must be limited to multiengine, turbine-powered rotorcraft for not longer than 30 minutes after failure of an engine. The use of 30-minute OEI power must also be limited by—

(1) The maximum rotational speed which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The maximum allowable gas temperature;

(3) The maximum allowable torque; and

(4) The maximum allowable oil temperature.

(h) *Continuous OEI power operation.* Unless otherwise authorized, the use of continuous OEI power must be limited to multiengine, turbine-powered rotorcraft for continued flight after failure of an engine. The use of continuous OEI power must also be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests.

(2) The maximum allowable gas temperature;

(3) The maximum allowable torque; and

(4) The maximum allowable oil temperature.

(i) *Rated 30-second OEI power operation.* Rated 30-second OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 2-minute OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 30-second OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with section A29.4 of appendix A of

rotor design; or

(ii) The maximum value demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(j) *Rated 2-minute OEI power operation.* Rated 2-minute OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 30-second OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 2-minute OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with section A29.4 of appendix A of this part and section A33.4 of appendix A of part 33. The use of 2-minute OEI power must be limited to not more than 2 minutes for any period in which that power is used, and by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(Amdt. 29–1, Eff. 8/12/65); (Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–15, Eff. 3/1/78); (Amdt. 29–26, Eff. 10/3/88); (Amdt. 29–34, Eff. 10/17/94); [(Amdt. 29–41, Eff. 11/28/97)]

§ 29.1522 Auxiliary power unit limitations.

If an auxiliary power unit that meets the requirements of TSO–C77 is installed in the rotorcraft, the limitations established for that auxiliary power unit under the TSO including the categories of operation must be specified as operating limitations for the rotorcraft.

(Amdt. 29–17, Eff. 12/1/78)

and

(c) The kinds of operation authorized under § 29.1525.

§ 29.1525 Kinds of operations.

The kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved are established by demonstrated compliance with the applicable certification requirements and by the installed equipment.

(Amdt. 29–24, Eff. 12/6/84)

§ 29.1527 Maximum operating altitude.

The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

(Amdt. 29–15, Eff. 3/1/78)

§ 29.1529 Instructions for Continued Airworthiness.

The applicant must prepare Instructions for Continued Airworthiness in accordance with appendix A to this part that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first rotorcraft or issuance of a standard certificate of airworthiness, whichever occurs later.

(Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–20, Eff. 10/14/80)

MARKINGS AND PLACARDS

§ 29.1541 General.

(a) The rotorcraft must contain—

(1) The markings and placards specified in §§ 29.1545 through 29.1565; and

(2) Any additional information, instrument markings, and placards required for the safe operation of the rotorcraft if it has unusual design, operating or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section—

For each instrument—

(a) When markings are on the cover glass of the instrument there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough and located to be clearly visible to the pilot.

§ 29.1545 Airspeed indicator.

(a) Each airspeed indicator must be marked as specified in paragraph (b) of this section, with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) A red radial line—

(i) For rotorcraft other than helicopters, at V_{NE}; and

(ii) For helicopters, at V_{NE} (power-on).

(2) A red, cross-hatched radial line at V_{NE} (power-off) for helicopters, if V_{NE} (power-off) is less than V_{NE} (power-on).

(3) For the caution range, a yellow arc.

(4) For the safe operating range, a green arc.

(Amdt. 29–15, Eff. 3/1/78); (Amdt. 29–17, Eff. 12/1/78)

§ 29.1547 Magnetic direction indicator.

(a) A placard meeting the requirements of this section must be installed on or near the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic heading in not more than 45° increments.

§ 29.1549 Powerplant instruments.

For each required powerplant instrument, as appropriate to the type of instruments—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

must be marked with red arcs or red lines; and

(e) [Each OEI limit or approved operating range must be marked to be clearly differentiated from the markings of paragraphs (a) through (d) of this section except that no marking is normally required for the 30-second OEI limit.]

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–26, Eff. 10/3/88); [(Amdt. 29–34, Eff. 10/17/94)]

§ 29.1551 Oil quantity indicator.

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

§ 29.1553 Fuel quantity indicator.

If the unusable fuel supply for any tank exceeds one gallon, or five percent of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

§ 29.1555 Control markings.

(a) Each cockpit control, other than primary flight controls or control whose function is obvious, must be plainly marked as to its function and method of operation.

(b) For powerplant fuel controls—

(1) Each fuel tank selector valve control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and

(3) Each valve control for any engine of a multiengine rotorcraft must be marked to indicate the position corresponding to each engine controlled.

(c) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

such as those showing rotor pitch or landing gear position, must be marked so that each crewmember can determine at any time the position of the unit to which it relates; and

(2) Each emergency control must be red and must be marked as to method of operation.

(e) For rotorcraft incorporating retractable landing gear, the maximum landing gear operating speed must be displayed in clear view of the pilot.

(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–24, Eff. 12/6/84)

§ 29.1557 Miscellaneous markings and placards.

(a) *Baggage and cargo compartments, and ballast location.* Each baggage and cargo compartment, and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) *Seats.* If the maximum allowable weight to be carried in a seat is less than 170 pounds, a placard stating the lesser weight must be permanently attached to the seat structure.

(c) *Fuel and oil filler openings.* The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with—

(i) The word "fuel";

(ii) For reciprocating engine powered rotorcraft, the minimum fuel grade;

(iii) For turbine-engine-powered rotorcraft, the permissible fuel designations, except that if impractical, this information may be included in the rotorcraft flight manual, and the fuel filler may be marked with an appropriate reference to the flight manual; and

(iv) For pressure fueling systems, the maximum permissible fueling supply pressure and the maximum permissible defueling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word "oil".

(d) *Emergency exit placards.* Each placard and operating control for each emergency exit must differ in color from the surrounding fuselage surface as prescribed in § 29.811(h)(2). A placard must be near each emergency exit control and must clearly

There must be a placard in clear view of the pilot that specifies the kinds of operations (VFR, IFR, day, night, or icing) for which the rotorcraft is approved.

(Amdt. 29–4, Eff. 10/17/68); (Amdt. 29–24, Eff. 12/6/84)

§ 29.1561 Safety equipment.

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signaling, or other life saving equipment, must be so marked.

(c) Stowage provisions for required emergency equipment must be conspicuously marked to identify the contents and facilitate removal of the equipment.

(d) Each liferaft must have obviously marked operating instructions.

(e) Approved survival equipment must be marked for identification and method of operation.

§ 29.1565 Tail rotor.

Each tail rotor must be marked so that its disc is conspicuous under normal daylight ground conditions.

ROTORCRAFT FLIGHT MANUAL

§ 29.1581 General.

(a) *Furnishing information.* A Rotorcraft Flight Manual must be furnished with each rotorcraft, and it must contain the following:

(1) Information required by §§ 29.1583 through 29.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) *Approved information.* Each part of the manual listed in §§ 29.1583 through 29.1589 that is appropriate to the rotorcraft, must be furnished, verified, and approved, and must be segregated,

(Amdt. 29–15, Eff. 3/1/78)

§ 29.1583 Operating limitations.

(a) *Airspeed and rotor limitations.* Information necessary for the marking of airspeed and rotor limitations on or near their respective indicators must be furnished. The significance of each limitation and of the color coding must be explained.

(b) *Powerplant limitations.* The following information must be furnished:

(1) Limitations required by § 29.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by §§ 29.1549 through 29.1553.

(c) *Weight and loading distribution.* The weight and center of gravity limits required by §§ 29.25 and 29.27, respectively, must be furnished. If the variety of possible loading conditions warrants, instructions must be included to allow ready observance of the limitations.

(d) *Flight crews.* When a flight crew of more than one is required, the number and functions of the minimum flight crew determined under § 29.1523 must be furnished.

(e) *Kinds of operation.* Each kind of operation for which the rotorcraft and its equipment installations are approved must be listed.

(f) *Limiting heights.* Enough information must be furnished to allow compliance with § 29.1517.

(g) *Maximum allowable wind.* For Category A rotorcraft, the maximum allowable wind for safe operation near the ground must be furnished.

(h) *Altitude.* The altitude established under § 29.1527 and an explanation of the limiting factors must be furnished.

(i) *Ambient temperature.* Maximum and minimum ambient temperature limitations must be furnished.

(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–15, Eff. 3/1/78); (Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–24, Eff. 12/6/84)

§ 29.1585 Operating procedures.

(a) The parts of the manual containing operating procedures must have information concerning any instructions for placing the fuel system in a configuration used to show compliance with that section.

(c) For helicopters for which a V_{NE} (power-off) is established under § 29.1505(c), information must be furnished to explain the V_{NE} (power-off) and the procedures for reducing airspeed to not more than the V_{NE} (power-off) following failure of all engines.

(d) For each rotorcraft showing compliance with § 29.1353(c)(6)(ii) or (c)(6)(iii), the operating procedures for disconnecting the battery from its charging source must be furnished.

(e) If the unusable fuel supply in any tank exceeds 5 percent of the tank capacity, or 1 gallon, whichever is greater, information must be furnished which indicates that when the fuel quantity indicator reads ''zero'' in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(f) Information on the total quantity of usable fuel for each fuel tank must be furnished.

(g) For Category B rotorcraft, the airspeeds and corresponding rotor speeds for minimum rate of descent and best glide angle as prescribed in § 29.71 must be provided.

(Amdt. 29–2, Eff. 6/4/67); (Amdt. 29–15, Eff. 3/1/78); (Amdt. 29–17, Eff. 12/1/78); (Amdt. 29–24, Eff. 12/6/84)

§ 29.1587 Performance information.

Flight manual performance information which exceeds any operating limitation may be shown only to the extent necessary for presentation clarity or to determine the effects of approved optional equipment or procedures. When data beyond operating limits are shown, the limits must be clearly indicated. The following must be provided:

(a) *Category A.* For each category A rotorcraft, the Rotorcraft Flight Manual must contain a summary of the performance data, including data necessary for the application of any operating rule of this chapter, together with descriptions of the conditions, such as airspeeds, under which this data was determined, and must contain—

(1) The indicated airspeeds corresponding with those determined for takeoff, and the procedures

under § 29.61 or § 29.63;

(5) [The landing data determined under § 29.81 or § 29.83; and

[(6) Out-of-ground effect hover performance determined under § 29.49 and the maximum safe wind demonstrated under the ambient conditions for data presented.]

(5) [The landing data determined under § 29.81 or § 29.83;

[(6) The steady gradient of climb for each weight, altitude, and temperature for which takeoff data are to be scheduled, along the takeoff path determined in the flight conditions required in § 29.67(a)(1) and (a)(2):

(i) In the flight conditions required in § 29.67(a)(1) between the end of the takeoff distance and the point at which the rotorcraft is 200 feet above the takeoff surface (or 200 feet above the lowest point of the takeoff profile for elevated heliports);

(ii) In the flight conditions required in § 29.67(a)(2) between the points at which the rotorcraft is 200 and 1000 feet above the takeoff surface (or 200 and 1000 feet above the lowest point of the takeoff profile for elevated heliports); and

([7]) Out-of-ground effect hover performance determined under § 29.49 and the maximum safe wind demonstrated under the ambient conditions for data presented.]*

(b) *Category B.* For each category B rotorcraft, the Rotorcraft Flight Manual must contain—

(1) The takeoff distance and the climbout speed together with the pertinent information defining the flight path with respect to autorotative landing if an engine fails, including the calculated effects of altitude and temperature;

(2) The steady rates of climb and hovering ceiling, together with the corresponding airspeeds and other pertinent information, including the calculated effects of altitude and temperature;

(3) [The landing distance, appropriate airspeed, and type of landing surface, together with all pertinent information that might affect this distance, including the effects of weight, altitude, and temperature;]

for minimum rate of descent and best glide angle, as determined in § 29.71;

(8) [Out-of-ground effect hover performance determined under § 29.49 and the maximum safe wind demonstrated under the ambient conditions for data presented; and]

§ 29.1589 Loading information.

There must be loading instructions for each possible loading condition between the maximum and minimum weights determined under § 29.25 that can result in a center of gravity beyond any extreme prescribed in § 29.27, assuming any probable occupant weights.